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AEROSPACE, CIVIL AVIATION

EC Commission on ESA Space Shuttle Role

AN890147 Luxembourg OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES in English No C104, 24 Apr 89 pp 14-15

[EC document: "Written Question No 1018/88" submitted by Carlos Robles Piquer, EC parliamentarian from Spain, to the EC Commission on 1 September 1988, and the reply by the Commission]

[Text]

European Prospects for the Space Station

What are the prospects for European cooperation in the design, construction and use of the space station in conjunction with the United States, Japan and Canada, using data produced by the European Space Agency? Would it be possible to outline in this way the nature of the European contribution to such an important project before the agreement is signed, which is expected to take place this autumn?

Answer Given by Mr Narjes [vice president of the EC Commission] on Behalf of the Commission on 15 December 1988

Europe through the European Space Agency will contribute an Attached Pressurized Module (APM) at the permanently manned base of the ISS (International Space Station, which is supported by United States and Canadian infrastructure), a laboratory (MTFF [Man-Tended Free-Flyer]) and a Polar Platform (PPF). The development cost of these three ESA elements is some $4 billion[1]. These elements will be developed under an ESA optional programme, the Columbus programme, in which 9 ESA member states are participating: the Federal Republic of Germany, Denmark, Spain, Belgium, France, Italy, the Netherlands, Norway, and the United Kingdom. The Columbus programme, however, fits into a larger European, in-orbit infrastructure programme, constituted by, for logistics, ESA's Hermes and Ariane 5 space transportation systems and, for communications, ESA's European Data Relay Satellite (EDRS). A series of ground facilities completes this picture of ESA's infrastructure linked to the space station. This programme will aim at maintaining and reinforcing European autonomy in space.

Management and a host of legal problems had to be worked out over a longer period, the result of which was the—now multilateral—Intergovernmental Agreement (IGA) between the United States Government and member states of ESA participating in the Columbus programme (Japan and Canada), plus three bilateral Memoranda of Understanding (MOUs) on the technical implementation of the Intergovernmental Agreement (IGA) (between NASA and ESA, MOSST and NASA, the Government of Japan and NASA). The IGA and the MOUs have been signed in Washington on 29 September 1988.

Footnote

1. The United States, Japanese and Canadian contributions to the development cost amount respectively to $18 billion, $2,5 billion, $1 billion.

FRG: R&D on Hypersonic Aircraft Intensified

MI890236 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in German No 499, 16 Mar 89 pp 4-5

[Excerpt] Reliable, low cost access to space is the precondition for continuous manned and unmanned space travel. Transport facilities are getting better with improved payload capacity, partial reusability, and reliability. Nevertheless, elimination of their remaining drawbacks can be expected following the development of an entirely new generation of transport systems. This was the message presented by Federal Research Minister Riesenhuber while introducing the new BMFT [Federal Ministry of Research and Technology] subsidy plan for hypersonic technology. The goals are the following:

- A clear reduction in transport costs through the transition to full reusability (cost reduction from the current $8,000/kg to $1,000 or $2,000/kg) while also eliminating trash in space;
- Improving safety and reliability by using the safety standards of aviation (e.g., with horizontal takeoff and landing).

The technological possibilities for such carrier systems have only begun to emerge over the past few years:

- Since 1986 the United States has aimed at the technologically most ambitious goal of a completely reusable, horizontal takeoff transport system, a "single-stage."
- Japanese industry and research have begun to work on single and double-stage transport systems.
- Apart from Hermes, French concepts for supersonic and hypersonic planes are being studied on the basis of the Concorde experience.
- British industry continues to promote the total single-stage space transport concept.

As defined in the FRG, the Saenger is conceived as a two-stage space transport system whose lower stage consists of a horizontal-takeoff, hydrogen-powered aircraft. The upper stage is an orbital vehicle equipped with a rocket booster unit. Both stages return to earth after completing their mission, and under the present concept they can be reused up to 150 times. In the distant future the lower stage could serve as the prototype for the development of a hypersonic transport plane.

A phased development is planned. The first phase (1988-92) involves a national technology program for which the BMFT intends to provide up to DM220 million in individual subsidies.

The FRG Bundestag's budget committee approved the release of the funds a few days ago. Roughly DM86 million will be added to these funds by the German Research and Experimental Institute for Aeronautics and Astronautics (DFVLR) for work in its research institutes. Beyond that, German Research Association (DFG) grants totaling some DM25 to 30 million will be added in Phase 1 to the aerospace industry's own funding estimated at roughly DM40 million.

The Aachen Technical University and the Universities of Braunschweig, Munich, and Stuttgart have filed applications with the DFG for the establishment of special hypersonic research programs.

The fundamental work of the DFVLR and the universities will address propulsion technology, aerothermodynamics, and materials/design, as well as the construction and operation of test facilities. It will be the important task of the universities in particular to train the next generation of qualified personnel for industry with newly created courses. Along with in-depth concept studies, subsidization of the aerospace industry's resource contribution will concentrate on technologies for the advanced air-breathing, hybrid engine of the Saenger lower stage.

In cooperation with other Europeans, Phase I could be followed by Phase II (demonstration of the components, 1993-1999) and thereafter Phase III (demonstration of the experimental vehicle). Around the year 2004 decisions could be made, primarily within the European Space Agency [ESA], on the development of the Saenger transport system.

As evidenced by the planning of the NASP (National Aerospace Plane) technology program that began in the United States in 1985-86, the preparation and testing of the propulsion technologies including a potential flight demonstration require more than 10 years. If we add the probable development and testing periods for the operational system, we can easily end up with a total of 20 years. Thus, it is clear that the promotion of hypersonic technology will not jeopardize the Hermes space shuttle project adopted by the ESA. Hermes will start operations by the end of this century. Its most important mission will be the regular support of the free-flying, unmanned laboratory being developed in the Columbus project and to carry its experiments back and forth.

The overall planning also includes a number of technologies that will be essential for the development and construction of Hermes. These technologies will also be used on the next generation of the horizontal takeoff space vehicles, especially for the airframe of the Saenger's lower stage and for the upper stage. The Hermes program cannot, however, make any contribution to the important area of propulsion technology, because Hermes does not have engines of its own. The technologies worked out under the Hermes program and under the subsidy plan for hypersonic technology are thus complementary and do not conflict. [passage omitted]

FRG: MTU, German Aerospace Authority Test New Turbofan

MI890198 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in German 21 Feb 89 pp 13-14

[Text] In reaction to the oil-price increases of the seventies, top international aircraft engine manufacturers have begun developing particularly cost-effective propeller engines for passenger planes known as "propfans." The goal is to extend the economic savings possible with propeller engines into the higher speed range, up to about 0.8 Mach. To date, these speeds have been attained only by turbofan engines.

MTU (Motoren- und Turbinen-Union GmbH) of Munich, in conjunction with the German Experimental Research Institute for Aeronautics and Astronautics (DLR), is concentrating on wind-tunnel tests of the CRISP [expansion not provided] turbofan. The total cost of the CRISP technology program, which has been underway since 1985, will amount to about DM98 million by 1991, with Phase II, which has just been approved and which will establish the demonstration engine's performance, accounting for DM46 million. The FRG Ministry of Research and Technology is contributing 50 percent of the costs.

The degree of international attention paid to the FRG's contribution to the definition of future aircraft engines became apparent recently at a European conference held in Munich. At the conference, nearly 100 representatives of Europe's most important airlines, aircraft manufacturers, institutes, and authorities were brought up to date on the current stage in the development of the new turbofans.

Agreements on close cooperation have been concluded with Pratt & Whitney (United States) and FIAT Aviazione to create a yardstick against which other propfan engines such as the ADP [Advanced Ducted Propfan] may be measured and to lay the groundwork for future international cooperation on developing a mass-produced propfan engine.

CRISP features two counter-rotating fan rotors with the backswept blades typical of propfans, housed in a low-resistance casing. This novel concept offers remarkable advantages.

The increase in fan diameter required to reduce consumption can be limited to such an extent that the engine can still be mounted on the wing or even the tail. The

introduction of the new propfan engines will thus make for significant savings in operating costs, particularly for aircraft serving medium and long-distance routes. Another advantage is that the current turbofan engines such as those mounted on the Airbus A320 or A340 can later be replaced by the more economical propfans.

The new propfans are expected to cut fuel consumption by 15-20 percent in comparison with current aircraft propulsion units. Apart from the development of low-pollution combustion chambers, which is also being subsidized by the BMFT [FRG Ministry for Research & Technology], the reduction in overall consumption constitutes an important and highly effective measure, especially from the environmental point of view.

As for noise generation and propagation, the casing acts as a sound barrier that will both limit the noise level in the cabin area to provide the same travel comfort as modern turbofan engines and, at longer ranges, satisfy even more stringent environmental noise control laws.

As with the turbofan, the casing is designed to retain any fragments in the event of a blade being shattered (for example, by impact with a bird). It may thus be expected to go a significant way toward providing the answers still being sought to the questions of the unencased propfan's licensing procedures and its acceptance by public opinion.

The CRISP technology program raises a large number of new questions and provides challenges that also offer German research and industry the chance to use this knowledge in the future in areas other than new types of engines, such as:

- Advanced computing methods for aerodynamics, structural mechanics and strength, rotor dynamics, and pollutant and noise emission analysis and design.
- New materials and construction methods for the blades, preferably using fiber composite structures, and the lightest possible castings (up to 3 m diameter); engine pod integration in particular holds out prospects of close cooperation between the airframe and engine manufacturing sectors.
- Individual components subject to extreme stress, primarily heavy-duty gearing in lightweight construction, designs for turbines subject to heavy stress and with reduced stage number, and compact hydromechanical systems for blade adjustment and thrust reversal.

Future tasks include an amplification of the wind-tunnel measurement facilities to accommodate aerodynamic and acoustic tests on the new propulsion systems under every conceivable operating condition (takeoff, cruising, reverse thrust, engine failure). These measurements are primarily carried out by the DLR, although a number are also performed in the German-Dutch wind tunnel (DNW), as well as in wind tunnels in other countries.

Meanwhile intensive work has begun in preparation for testing the entire "turbofan" system within the framework of a demonstration flight project. The advantages of the new propulsion systems can be proven conclusively only if they are put through the intermediate step of testing under realistic operating conditions.

Further details are available from Dr Bergmann, BMFT Aviation Research Project Back-Up Unit, Industrieanlagen Betriebsgesellschaft GmbH, Einsteinstr. 20, 8012 Ottobrunn, [FRG], tel. 089/60883407.

BMFT Outlines Hypersonic Technology Development Plan

36980248 Bonn FOERDERKONZEPT HYPERSCHALLTECHNOLOGIE in German 1988 pp 1-41

[Text]

1. Introduction

Present space transportation systems are expensive. These high transportation costs which place limits on the development of astronautics are attributable to a large extent to the fact that the individual systems can only be used once. Efforts, led by the United States, are therefore under way throughout the world to develop horizontal takeoff, fully reusable space aircraft. This presents the FRG with an opportunity to assume a leadership position in this strategically important sector of astronautics by engaging in goal-oriented, coordinated technological research programs.

To take advantage of this opportunity, the BMFT has initiated a plan to promote development of hypersonic technology which is oriented toward the SAENGER two-stage, fully reusable space transportation system.

The plan, based on jointly elaborated and supported objectives and measures, is the result of a concerted action by the BMFT, industry, and the research community. This finds particular expression in the funding provided by industry to finance technology projects.

The plan is divided into the following stages:

Stage 1 (1988-1992) consists of a purely national technology program for which the BMFT intends to provide up to DM 220 million in subsidies for individual projects. The DFVLR or Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt [German Research and Testing Laboratory for Aeronautics and Astronautics] will provide about DM 86 million more. The aerospace industry and the German Research Association for Projects at Academic Institutes are also expected to provide support for the project.

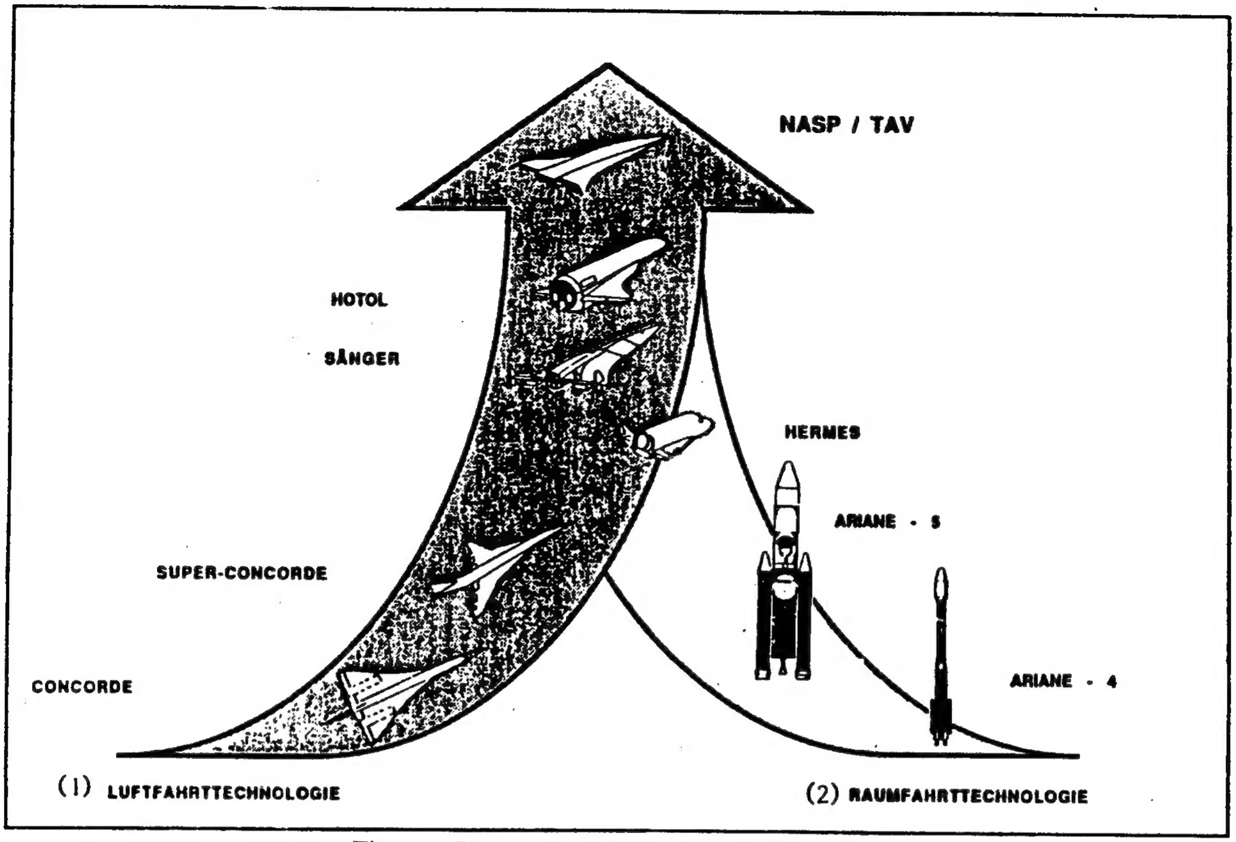

Figure 1. Development Stages Toward Space Plane

Key: 1. Aeronautical technology—2. Space technology

After a milestone decision at the end of stage 1, stage 2 (demonstration of components) and stage 3 (demonstration of the experimental aircraft) will follow as cooperative European efforts. Subsequent development of the SAENGER transport system would primarily be decided upon within the framework of the European Space Agency (ESA). At the appropriate time, the FRG would submit such an initiative to the organization.

2. Significance and Classification of Hypersonic Technology

2.1 Economic Significance and Need

The stated goal of hypersonic activity in the United States, France, and Japan has been to initiate decisive impulses for large and far-reaching technological thrusts and to make substantial contributions for their future maintenance. In addition, the need for cost-effective space transportation systems has been assigned an increasing role, especially in the United States. This also includes the hypersonic air travel project nicknamed "Orient Express."

Future space transportation systems will have to satisfy many of the customary requirements of present-day civil aviation such as economy, reliability, durability, and brief turnaround times. In addition, the measures and procedures normally employed in civil aviation will have to be combined with those used in astronautics. It is therefore likely that aviation and space technologies will be consolidated (Figure 1). This will find expression in the external shape of the flight units.

Consolidation of air and space travel in the field of hypersonic transportation systems can lead to greater economies through the broadest possible creation and use of joint technologies and to synergetic results through the concentration of resources.

Aeronautic Requirements

In years to come, there will be a growing need in aeronautics for high-speed transportation capabilities (in excess of Mach 2). Greater airspeed, however, will increase the productivity of individual aircraft and this, in turn, will reduce the number of aircraft required.

Although civilian air transport might still be technically and operationally feasible at speeds of Mach 4 to 5, the number of aircraft needed would probably be so small that the expenditures for development and production would no longer be economically justifiable.

As things stand therefore, civilian transport aircraft flying at speeds in excess of Mach 3 are unlikely to be built in the foreseeable future.

It may be expected, however, that military needs will arise for medium-range reconnaissance systems operating at speeds of about Mach 5.

Astronautic Requirements

The highest priority goal of astronautics is to lower transportation costs significantly and to enhance reliability. As things presently stand, the most promising way to achieve this would be multiple reuse of transportation systems. Such reusability could primarily be guaranteed by taking advantage of the atmosphere for lift and propulsion purposes and resorting to horizontal takeoffs and landings. This, in turn, would result in greater reliability, based on the experiences gained in civil aviation.

Generally speaking, therefore, hypersonic technology presents an interesting potential for air and space travel. Perhaps the most important reason why the BMFT has decided to promote development and to assess the technical chances of realizing the project as well as to evaluate its economic aspects is the assumption that it can thereby make a contribution to the more extensive use of astronautics. Experiences gathered in the course of the development phase are likely to provide technological impulses to "classic" aeronautics. Spinoff effects are also likely to occur in other high-tech areas of industry.

2.2 State of Technology

2.2.1 Activities in Germany

In 1962, a number of firms belonging to the then still splintered German aerospace industry initiated wide-ranging study programs into the feasibility of horizontal takeoff, two-stage, reusable space transportation systems. Especially with respect to propulsion, these studies came up with a variety of concepts all of which posed exceptional technological challenges. In fact, the most challenging problems arose in the area of propulsion and at the time no immediate solutions were found in the case of air breathing propulsion systems or of actual rocket propulsion systems.

In the late sixties, the specifics of the so-called "return technology program" or ART were worked out. The goal of ART was to develop a return-capable space glider model and to launch it atop a European rocket at the Woomera launch site in Australia within 10 years. A definitive decision by the BMFT to implement a comprehensive program along these lines was not forthcoming. Nevertheless, a number of wind tunnel tests independent of the actual program were funded and carried out to provide a comparative evaluation of two configurations (i.e., the ART 24 A and B, which have been back in the news in connection with the "Hermes" project). In addition, drag models were developed and built for subsonic drag tests. In the summer of 1973, initial drag tests took place on the island of Corsica even though the program as a whole was not undertaken because of the uncertain situation. At length, the BMFT decided to terminate further funding in 1974. As a result, ART activities in support of the program conducted by the DFVLR and by university research institutes which concentrated on the study of hypersonic combustion and air breathing space engines were gradually phased out.

Prior to the decision on a long-range plan for ESA (particularly with regard to Hermes), it became necessary once more to undertake a comparative evaluation of alternative transportation systems. In this connection, both the Hermes technologies and other transportation system concepts were evaluated. In addition, studies on the technological requirements of supersonic and hypersonic transport aircraft up to and including the high Mach numbers of space transportation systems were carried out. The results of these studies the cost of which amounted to some DM 15 million demonstrated that the speed limitations of future transportation systems were dictated by the materials and propulsion systems used.

While the concept studies showed that a two-stage, fully reusable space transportation system (SAENGER) is an especially flexible and multi-faceted system in terms of technology, the technological studies found that the traveling speed of the SAENGER lower stage, i.e., around Mach 5, represented a particularly spinoff-prone speed range. Above Mach 5, the technological problems tend to increase dramatically and along with these the risk of not being able to achieve more extended flight times in space. Speeds of less than Mach 5, on the other hand, are of only limited use in astronautics. The above findings lead one to the conclusion that SAENGER should serve as the basic concept for the development of hypersonic technology.

No major programs on flight ranges above Mach 3 have been carried out during the past decade, with the exception of some hypersonic aerodynamics activities in the DFVLR and industry projects devoted to ramjet engines and missiles. The wind tunnels which were highly advanced by the standards of the sixties and early seventies were not developed further but in fact decommissioned for the most part. In subsequent years, university research into hypersonic flight was severely curtailed. Resumption of activities did not occur until orders for the Hermes program started to come in.

2.2.2 Present Situation in Foreign Countries

On 4 February 1986, the President of the United States announced his decision to implement a technology program (i.e., the National Aerospace Plane or NASP program) to lay the groundwork for the development of hypersonic aircraft. This program is viewed as a major step toward expanding upon the leadership position of the United States and securing it until far into the next century.

Other industrialized nations have also undertaken efforts which point in the same direction. France and England are two West European nations which have been gathering special expertise based on their 10 years of experience with the "Concorde" and a number of supersonic military projects (e.g., Mirage, Jaguar, and guided missiles). In addition to the already Europeanized Hermes project, France is carrying out studies into a supersonic and a hypersonic concept, e.g., the Avion de Transport Supersonique Futur or ATSF [Supersonic Transport Aircraft of the Future] and the Avion de Grande Vitesse or AGV [High-Speed Aircraft]. Great Britain is working on the proof of concept for a one-stage (thus far unmanned) space transportation system named HOTOL [Horizontal Takeoff and Landing] which aims to lower takeoff cost by 80 percent as compared to present rocket-propelled launch systems.

In Japan, development of reusable space transportation systems, i.e., the HIMES [Highly Maneuverable Experimental Space Vehicle] and the HOPE [H-II Orbiting Plane] is being pushed forward.

The USSR is said to be on the verge of introducing new space vehicles. A reusable space aircraft capable of carrying a payload of 15 tons and a space shuttle capable of carrying a payload of 30 tons are said to be in the final stage of development. The space shuttle's rocket-propelled launch system underwent successful tests for the first time on 15 May 1987.

2.2.3 Starting Situation in Germany

Against this international background, the situation in the FRG is as follows: Aside from the Tornado program and various missile projects, the German aviation industry has not been involved in the development of supersonic aircraft thus far. Hypersonic research activities were largely terminated in the mid-seventies. Nevertheless, the concept studies for SAENGER and the availability of the technological potential of the German aerospace industry as well as the know-how of the DFVLR provide a solid basis for carrying out a promising hypersonic technology program aimed at clarifying basic needs so that a comprehensive development program can be initiated a few years hence.

Intensive, goal-oriented collaboration between industry, research, and government as well as major additional funding are required for proceeding with the program. All of the participants in the program must contribute fully to its objectives and major efforts. An appropriate organizational structure as well as close coordination are indispensable in order to accomplish the assigned tasks on schedule and within budget.

The hypersonic technology program must focus on the solution of the technical problems confronting air breathing high speed propulsion units because that unit represents the most formidable technological challenge and because the airframe cell is developed "around the propulsion unit."

3. Objectives

3.1 Strategic Objective

At the very latest, the Challenger disaster early in 1986 and the resultant delays in many space programs made it clear that space transportation systems have a key strategic role to play. Furthermore, the lengthy development times of space transportation systems such as the Space Shuttle, the Ariane-5, and Hermes demonstrate that space transportation systems are especially demanding and complex in technological terms.

The SAENGER concept developed in the FRG has defined a particularly demanding technological project. It creates an opportunity for the FRG to contribute in an exemplary way to the development of more cost-effective and more reliable transportation systems of the future and to assume responsibility commensurate to its general economic and technical capabilities.

3.2 Technological Objectives

3.2.1 SAENGER Basic Concept

The basic concept is the SAENGER space transportation system proposal consisting of a horizontal takeoff winged lower stage and a mounted, manned HORUS [Hypersonic Orbital Upper Stage] space glider and/or an unmanned CARGUS cargo upper stage. The name SAENGER was given to the vehicle in honor of the achievements by space pioneer Eugen Saenger (1905-1964) who was the first to propagate the concept of a winged space transport vehicle and who played an important role in the development of rocket and ramjet engines. The lower stage of the basic concept is of import with regard to technological functions (cf. Figures 2 [photo not reproduced] and 3).

Major Configuration Characteristics of Lower Stage

- Integrated wing-fuselage combination with semi-submerged upper stage.
- Inclusion of intake and nuzzle geometry in fuselage contour (integration of propulsion unit).
- Steering with trailing edge flaps and tail flap (with nozzle influence); ducktail assembly with variable geometry, if needed.
- Preliminary mass and measurements as per Figure 3.

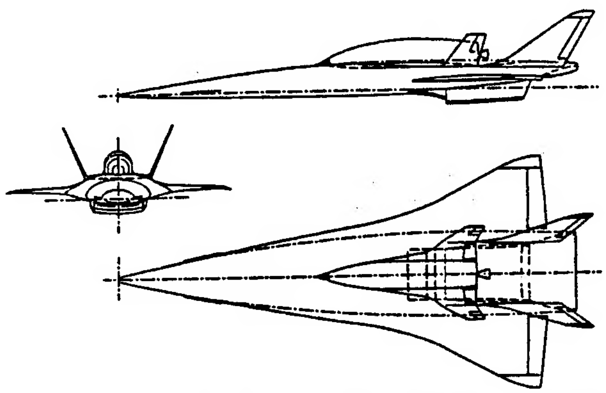

Figure 3. SAENGER Views and Specifications (Preliminary Base Concept)

SAENGER	Lower stage	HORUS	CARGUS
Overall length	84.5 m	32.8 m	33.0 m
Wing span	41.4 m	17.0 m	Unwinged
Empty weight	143 t	22 t	6 t
Fuel weight	100 t	65 t	55 t
Payload weight	91 t (HORUS) 76 t (CARGUS)	2-4 t	10-15 t
Liftoff weight	334 t (with HORUS) 319 t (with CARGUS)	91 t	76 t
Air speed	Ma = 4.4 (Cruising speed) Ma = 6.8 (Stage separation)	Ma = 25 (Reentry)	Orbital speed
Engines	Air breathing	Rockets	Rockets
Number times thrust	5 x 360 kN	1 x 1200 kN	1 x 1050 kN

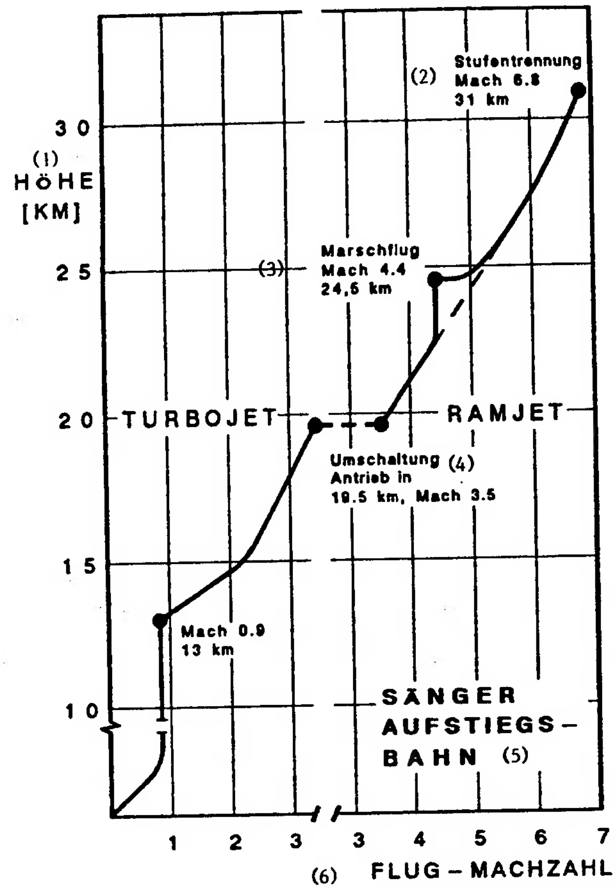

Figure 4. SAENGER Mission Profile

Key: 1. Altitude in kilometers—2. Stage separation—3. Cruising speed—4. Propulsion changeover—5. Ascent trajectory—6. Flight-Mach number

Flight Performance and Other Technical Data

The mission profile characteristics are as follows:

- Takeoff and landing at existing airfields in Europe.
- Cruising speed between Mach 4 and Mach 5; cruising altitude about 25 kilometers, i.e., above the ozone layer.
- Acceleration to Mach 6 to 7 to effect separation of upper stage.
- Return to takeoff site.

Propulsion Concept

Turbo/ramjet or turbo/rocket engines based on various hydrogen propulsion concepts (cf. Figure 5).

Thermal Balance

Thermal insulation using special wall material and active cooling of engine using fuel.

Major Problems

- The size, weight, and shape of the upper stage have a major bearing on the corresponding parameters of the lower stage.
- The Mach number at separation has a major bearing on the weight of the upper stage, i.e., the greater the Mach number, the less weight with payload remaining constant.
- The type of cruising flight determines the design.
- The integration of the upper stage has a bearing on the stability and steerability as well as the flight performance of the entire system and the fuselage structure.

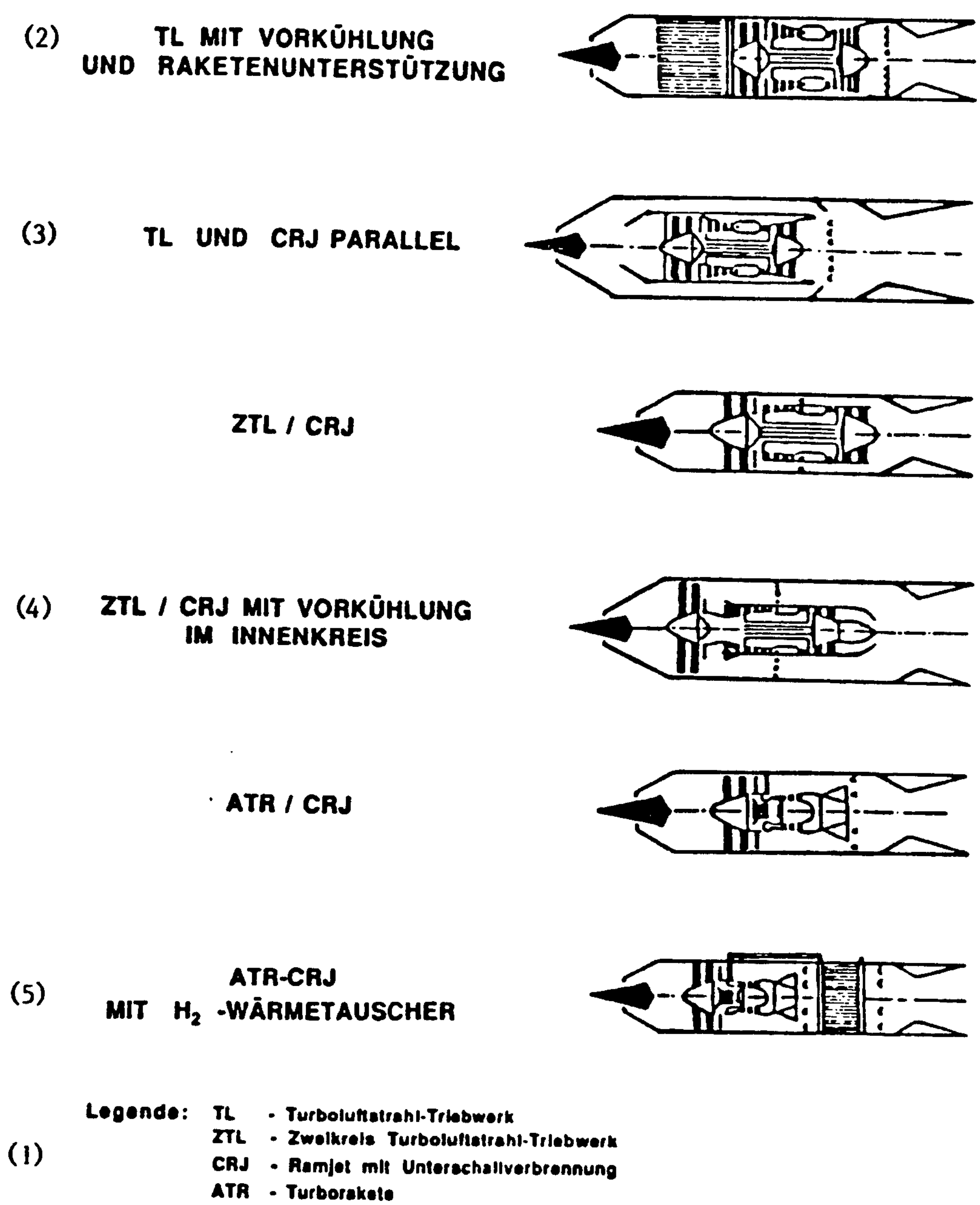

Figure 5. SAENGER Propulsion Concepts

Key: 1. Abbreviations: TL = turbojet engine; ZTL = twin engine turbojet propulsion system; CRJ = subsonic combustion ramjet; ATR = turborocket—2. Precooled, rocket-assisted TL—3. Parallel TL and CRJ—4. Precooled internal circuit ZTL/CRJ—5. H_2 heat exchanger ATR-CRJ

- The airworthiness of the lower stage must be ensured both during and after separation (instantaneous balance).
- Attainable maximum glide ratios have a major bearing on the weight and flight performance of the lower stage (good aerodynamic design).
- Intake and nozzle geometry have a bearing on fuselage structure and flight characteristics.

Generally speaking, the most serious problems are caused by high surface temperatures which tend to rise dramatically as Mach numbers increase (cf. Figure 6). For another thing, the extended range of speed calls for variable or combined propulsion units in order to ensure maximum engine performance through the use of maximum specific impulses (cf. Figure 7).

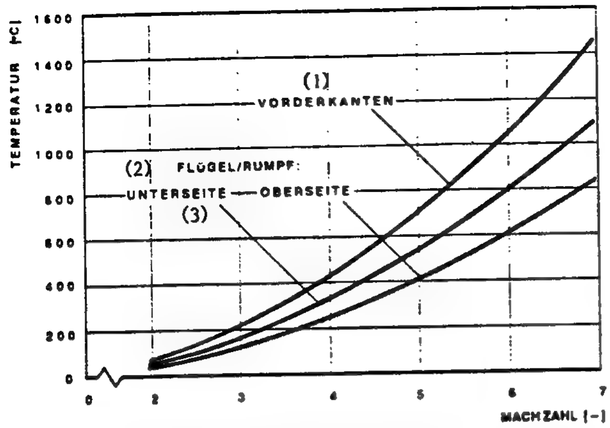

Figure 6. Surface Temperature-Mach Number Ratio

Ke: 1. Leading edges—2. Wings/fuselage—3. Bottom side/top surface

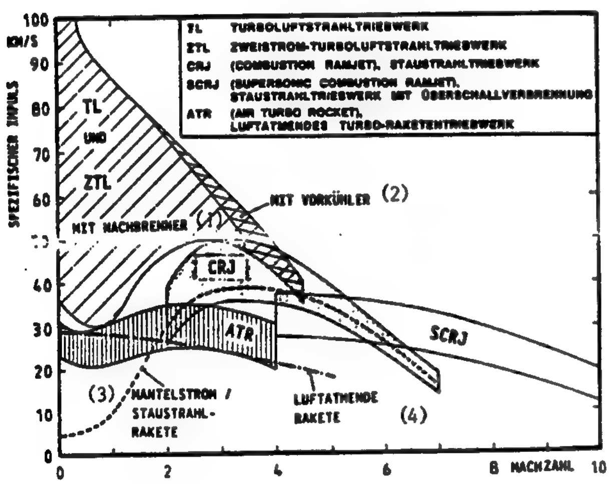

Figure 7. Specific Impulse-Mach Number Ratio

Key: 1. With afterburner—2. With precooler—3. Bypass turbofan rocket—4. Air breathing rocket

3.2.2 Technological Challenges

Another thing which speaks for the selection of the SAENGER concept is the growing tendency of air and space technologies to overlap at speeds above Mach 4. Complete familiarity with this sector of technology is one of the requirements the aerospace industry must fulfill in order to remain competitive in the nineties.

Major technological challenges are to be met in the area of propulsion technology, aerothermodynamics, new materials (including the appropriate production techniques), and in a variety of systems technology sectors. Numerical simulation equipment is another major item needed for rapid and efficient evaluation and design optimization of all transportation and propulsion systems. As a first step, this equipment needs to be updated and perfected and the high-performance computers required for its operation must be made available insofar as sufficient funds exist to purchase them. In support of these measures, any deficiencies in the basic scientific data on propulsion technology must be rectified in order that technologies can be tackled. With the help of improved equipment and better basic data, thoroughgoing design analyses and feasibility studies of the highly integrated concepts for air speeds of about Mach 5 and more are to be undertaken.

The actual functioning of the technologies and components devised is to be demonstrated on experimental prototypes and, where necessary, with the help of the major participants in the program.

4. Structure of Plan To Develop Hypersonic Concept

The overall concept submitted here will take 15 to 17 years to complete (cf. Figure 8). It is divided into several sequential stages so that a decision to carry on with the overall program can be made on the basis of an evaluation of the preceding stages. Furthermore, milestones have been placed at intervals within the various stages which permit an evaluation of the concept and of the desired individual objectives of the sequential stages.

The concept was prepared out in 1986 and 1987 by BMFT studies on the "determination of key technologies as starting points for German industry with particular reference to possible hypersonic projects," by concept studies for future space transportation systems, and by the high technology-astronautics task force of the DFVLR.

The overall concept begins with a technology stage (stage 1) in the course of which outstanding detailed concept studies are supplemented in increasing measure by technological programs. In the course of this stage, the necessary test sites are built and older and still usable sites are modernized.

The focus of the first stage is on a detailed systems analysis for the purpose of verifying the SAENGER basic concept. Above and beyond providing for a gradual hardening and refinement of the basic concept it should lead to clearer understanding of concepts adopted by other nations. The analysis thus is of major strategic significance. In addition, the analysis is designed to ensure the fastest and most thorough possible understanding of all problem areas of the two-stage SAENGER transportation system concept as well as the determination and orientation of all technology concepts.

Parallel to the detailed SAENGER concept analysis, IABG [Industrial Installations Ltd.] is to conduct a comparative systems analysis by 1990 at the latest with

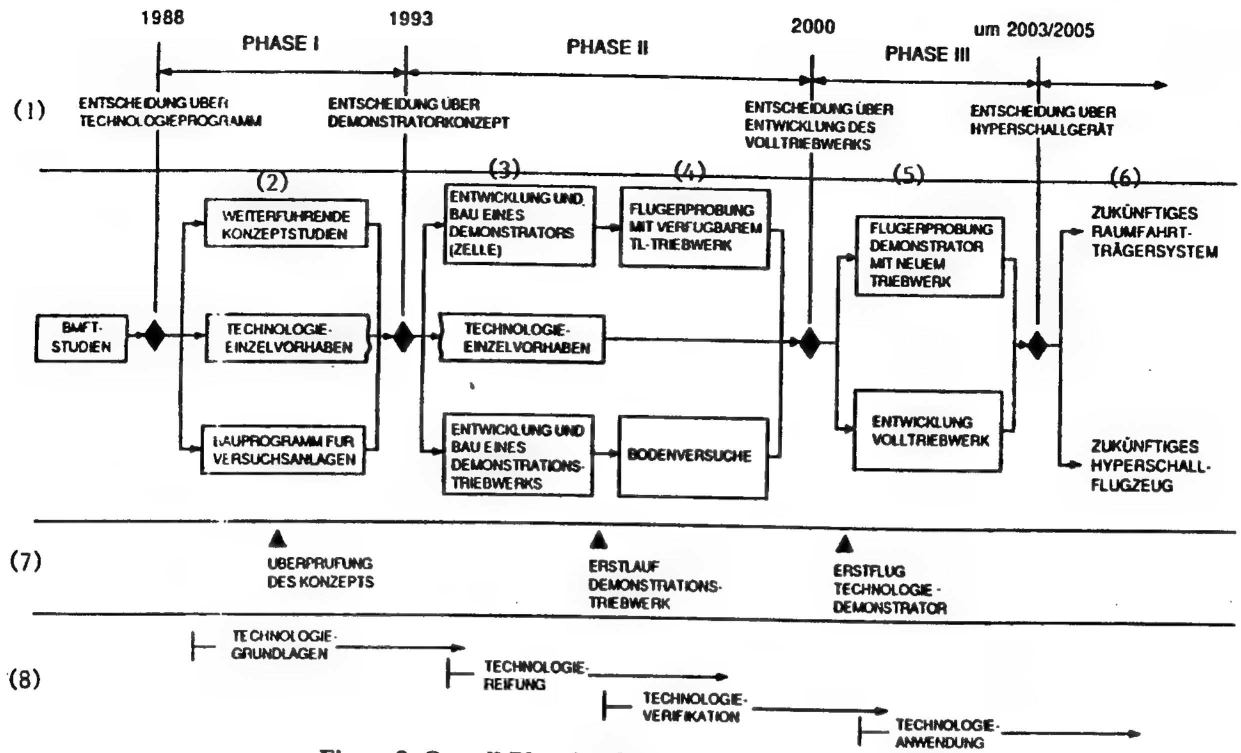

Figure 8. Overall Planning Scheme of Hypersonic Project

Key: 1. Decision on technology program; on demonstrator concept; on engine development; on hypersonic vehicle—2. BMFT studies: follow on studies; individual technology projects; test site construction program—3. Development and construction of demonstrator (airframe); of demonstrator engine—4. Flight test with TL engine; ground tests—5. Flight test of demonstrator with new engine; development of complete engine—6. Future space cargo vehicle; future space plane—7. Check out of concept; initial test of demonstrator engine; of technology demonstrator—8. Technology bases; classification; verification; application

the assistance of reputed university professors. This analysis should focus on the compilation of major technical and scientific data, e.g., possible missions, weight breakdown, reliability; development and operation costs relating to the following transportation systems and a comparison between them:

- Space glider in combination with booster rocket (Hermes, Space Shuttle).
- Two-stage, fully reusable space transportation system (SAENGER).
- One-stage, fully reusable space aircraft (NASP, HOTOL).
- Other future space transportation system.

It is the purpose of this analysis to contribute to measuring the expected specific advantages of the SAENGER concept against internationally significant transportation system concepts and, if need be, to adjust it in line with changing requirements and technical developments.

In view of the exceptional importance of the propulsion unit of space aircraft, provision has been made for a propulsion unit concept study during the first stage of the project and for separate feasibility studies on a propulsion unit demonstrator (80-100 kN) and the full-scale SAENGER propulsion unit (300-400 kN). The development of component technologies for the demonstrator, however, extends beyond the first stage and is likely at least partially to exceed the availability of German resources.

Current plans call for the development of the flight demonstrator as an engineering development model for the technologies developed during this first stage of the project, assuming that the following procedures have been successfully completed by the end of stage 1:

Test of propulsion unit components, i.e., intake, compressor, engine chambers, turbine, nozzle, and auxiliary units; wind tunnel qualification of propulsion unit/airframe integration; wind tunnel qualification of stage separation at Mach 6 and Mach 7; qualification of metal structural elements for lower stage of SAENGER at temperatures up to 700°C; development of integratable cryotanks to meet the mechanical and thermal requirements of the flight demonstrator.

Because of the rise in costs in conjunction with this, the plans are to carry out stage 2 as a cooperative international project. The demonstrator could be designed as an aircraft capable of flying at speeds of Mach 5 or more, built on a scale of 1:4 to the lower stage of SAENGER. Stage 2 is to establish the basis for a decision to undertake development and testing of a full-size propulsion unit for the lower stage of SAENGER (stage 3). Because of the long lead time involved, the requirements to be met by stage 3 can only be stated in outline form at this point. The following requirements will probably have to be met in entering upon stage 3:

Final acceptance trial of the complete airworthy demonstrator propulsion unit; in-flight demonstration of the engineering development model at speeds of at least Mach 5 in order to verify aerothermodynamic requirements plus demonstration of stage separation, using a model of the SAENGER upper stage; verification of the long-term temperature stability of selected materials and types of construction at speeds of approximately Mach 5; verification of operability of the integrated hydrogen tank throughout the entire flight range.

At the conclusion of stage 3, the decision to proceed with development of such space transportation systems could then be made.

5. Primary Technological Objectives of Stage 1

5.1 Basic Efforts by DFVLR and Academic Research Programs

In coordination with industry and the academic community, the DFVLR intends to do its share in assigning substantial personnel and financial resources to stage 1 of the project in all the major areas, e.g., propulsion, aerothermodynamics, materials, types of construction as well as flight control and systems. The academic institutions will participate in the main in the area of special research into the design and the basic features of propulsion technologies. They will also be performing the important task of training hypersonic engineers to satisfy the future requirements of industry.

The DFVLR will be primarily responsible for research programs to prepare the necessary design principles and basic technologies, making use of test sites and supercomputers in close cooperation with the aerospace industry. The major areas for which the DFVLR and the cooperating institutes will be responsible are listed below.

In the propulsion area, the DFVLR is responsible for analyzing thermodynamic processes and structural problems of components under strong thermal stress, including the necessary cooling processes. In addition, it investigates the basic principles of hydrogen/air combustion and the high-temperature flow processes in variable geometry turbo engines.

Participating Institutes

Propulsion technology, Cologne-Porz; types of construction and construction research, Stuttgart; chemical propulsion and process engineering, Lampoldshausen; physical chemistry of combustion, Stuttgart; materials research, Cologne-Porz.

In the area of aerothermodynamics, basic fluid mechanics research into hypersonic boundary layers and boundary layer interferences will be carried out. In addition, numerical processes will be developed and experimentally verified, with particular emphasis on test technology and metrology.

Participating Institutes

Experimental fluid mechanics, Goettingen; theoretical fluid mechanics, Goettingen; main department, wind tunnels, Goettingen.

In the area of materials/types of construction, priority will be assigned to the development of materials with sufficient stability and resistance at high temperatures, focusing on thermal insulation and thermal balance.

Participating Institutes

Structural mechanics, Braunschweig; aeroelastics, Goettingen; materials research, Cologne-Porz; types of construction and construction research, Stuttgart.

In the area of flight control and systems, problems of flight control will be dealt with, particularly those involving the critical landing phase and the difficult reentry phases (e.g., electromagnetic blackout). In addition, the cockpit man/machine interface is to be developed further.

Participating Institutes

Flight mechanics, Braunschweig; flight control, Braunschweig; flight system dynamics, Oberpfaffenhofen.

DFG-financed special research programs in support of the hypersonic development project are planned at various technical universities. The research programs include all the competent institutes and their specialized activities.

At the RWTH [Rhenish-Westphalian Technical University] Aachen, for example, a special long-term research program into the "basic principles of the design of space aircraft" has been developed. The program will deal with configuration analyses of hypersonic vehicles and an investigation of aerothermodynamic principles and thrust production. The following institutes will participate in the program: the institute for aeronautics and astronautics; the institute for lightweight construction; the institute for jet propulsion and turbo machinery; the

institute for thermal technology and industrial furnace construction; the aerodynamics institute; the institute for mechanics and the RWTH Aachen shock wave laboratory.

Braunschweig Technical University plans to concern itself with the flight physics aspects of space transportation systems. The university research program on aerothermodynamics, orbital mechanics and flight control, structure, types of construction and environmental interaction will be carried out in close cooperation with the DFVLR.

The following institutes will participate in the program: the institute for fluid mechanics; the institute for flight control; the institute for flight mechanics; the institute for astronautics and reactor technology; the institute for geodesy; the institute for aircraft and lightweight construction; the institute for thermodynamics; the institute for meteorology and climatology; the institute for geophysics and meteorology; the Max Planck Institute for aeronomics and the research center for plasma technology production processes.

In collaboration with the University of the Bundeswehr in Munich and the DFVLR in Oberpfaffenhofen, Munich Technical University has worked out a joint research program to investigate basic flight physics principles for transatmospheric transportation systems. In addition to systems technology evaluations aided by computer-assisted design processes, priority will be given to basic research into aerothermodynamics and to propulsion system analyses. It is also planned to work on problems relating to flight mechanics, materials, and structures. The departments and/or institutes listed below are planning to take part in the program.

At Munich Technical University: the department for flight propulsion; the department for flight mechanics and flight control; the department for lightweight construction; the department for mechanics; the department for metallurgy and metallography; the department for fluid mechanics; department A for thermodynamics; department B for thermodynamics; the department for space technology and the department of mathematics.

At the University of the Bundeswehr: the institute for aeronautics technology and lightweight construction; the institute for fluid mechanics and aerodynamics; the institute for thermodynamics; and the institute for the science of materials.

At the DFVLR in Oberpfaffenhofen: the institute for flight system dynamics.

A special research program conceived by the aerospace department of Stuttgart University will concentrate on the problems of hypersonic propulsion with emphasis on the basic principles of supersonic combustion. The program will include work on propulsion concepts and on performance evaluation procedures for hypersonic propulsion units; experimental and theoretical research into the phenomenology of supersonic combustion and experimental research into compression relating to propulsion units for hypersonic missiles. Additional research programs will focus on the relaxation characteristics of real gases and the boundary layer stability of supersonic flows as well as on mission and system requirements. The institutes enumerated below (some of which are collaborating closely with the corresponding Stuttgart DFVLR institutes) are planning to participate.

The institute for aeronautic propulsion systems (with elevation test stand); the institute for aerospace thermodynamics; the institute for aerodynamics and gas dynamics; and the institute for astronautic systems.

5.2 Propulsion Technology

Verification of the suitability and operability of the propulsion unit are indispensable for the development of air breathing propulsion space transportation systems. Such verification is therefore the main component of the development concept and comprises the major part of expenditures and activities.

The priority programs involving basic and component technologies include the development of a high-flexibility, high-temperature fan and the demonstration of same under realistic operating conditions; a ramjet combustion chamber for hydrogen operation and the demonstration of same under realistic operating conditions; an aerodynamic variable hypersonic intake model and a wind tunnel test of same; components of a variable jet for a hydrogen-propelled engine and the functional demonstration of same under realistic operating conditions and heat transfer elements for hydrogen cooling and/or hydrogen warmup and the functional demonstration of same under realistic operating conditions.

The first three of the above are high-priority projects because the operability of the entire propulsion concept depends on their successful completion. In addition to these projects, a number of projects of lesser priority must also be tackled. The preparation of a turbo ramjet experimental engine with a thrust of about 80 to 100 kN is still another project of special importance. This involves the solution of critical design problems and component technologies as well as the construction and testing of the entire turbo group and of the ramjet component.

5.3 Flight Unit Technologies (SAENGER Lower Stage)

The individual technology projects designed to work out the component technologies significantly contribute to verification of the feasibility of the SAENGER concept in the specialized areas of aerothermodynamics, materials/types of construction and in flight control and systems. This is where the preconditions for the fulfillment of systems requirements (including interaction with the

air breathing engine) are established and where the suitability of particularly risk-prone components can be individually tested under physical operational conditions.

5.3.1 Aerothermodynamics

In the aerothermodynamics field, the quality of available computing methods and feasible experiments decides on the reliability of findings relating to system layout and configuration. This calls for high priority projects, e.g., adjustment of design and layout procedures; development and updating of hypersonic computing methods and computational procedures; research to verify procedures experimentally; integration of propulsion unit with the aid of computation methods and experiments to supercharge and post-expand engine air; and model tests for stage separation.

The first three problems need to be solved both for the aerodynamic and thermodynamic interactions between the airframe contours and the airstream. Quality depends on the availability of sufficient computer capability, i.e., computer time, storage location, adequate computer structures, and the availability of suitable wind tunnels.

5.3.2 Materials and Types of Construction

In this area of technology the priority tasks include the following: development and testing of primary structure titanium components for operation at temperatures up to 700°C; efficient production of carbon fiber-reinforced carbon components and oxidation protective layers for operation at temperatures up to 2,000°C (leading edge of upper stage upon reentry); production of fiber-reinforced ceramic components (e.g., engine intakes) and demonstration of same under realistic operational conditions; and development and production of liquid hydrogen tank structures.

All of the above are high priority projects because the attainment of the necessary low structural weights combined with the utilization of high-temperature resistant materials represents one of the most formidable risks in the development of space transportation systems. This is why the materials/types of construction technology field focuses to a large extent on thermal insulation and control. For this reason there is a need for some especially complicated types of construction because of at least locally indispensable cooling requirements.

5.3.3 Flight Control and Systems

Somewhat low priority has been assigned to this particular area of technology for two reasons. For one thing, the development of these technologies proceeds at a rather rapid pace so that efforts in this field need not be intensified until later and for another, a fairly high state of development has already been achieved so that the flight control projects must not really be undertaken until the bigger risks relating to the other technologies necessary for implementation of the SAENGER concept have been largely overcome.

The important projects in this field concern systems which interact with other areas of technology, e.g., active thermal insulation, thermal balance, cabin climate, rescue systems; secondary energy generation; and control technologies.

But projects relating to flight control, navigation, and the man/machine interface should be pursued with at least some effort.

5.4 Pilot Plants and Supercomputers

As a consequence of the above-mentioned interruption in hypersonic activity in Germany, there is a need to update the equipment conceived and built in the sixties and in part to replace it with new equipment. This applies to hypersonic wind tunnels for example. In other areas, e.g., in propulsion technology, entirely new installations have to be built for the most part. One important aspect concerns supercomputers because available computer capabilities are inadequate for the many simulations in different technical fields. New supercomputers which will be coming on the market during the next few years will have to be installed. A detailed plan will be worked out during the initial segment of stage 1, i.e., until the middle of 1990, which will form the basis for concrete investment decisions.

5.4.1 Propulsion Test Stands

The objective of the development concept is the component development for an air breathing propulsion unit capable of achieving extended flight times at speeds up to Mach 5 and shorter flight times at top speeds up to Mach 7. The propulsion and test facilities serve the important purpose of testing these components up to entire partial systems or subunits of the propulsion system. As part of the preparation for subsequent test facilities to check out the propulsion unit, the intakes and nozzles, the measures that need to be undertaken during stage 1 of the technology program in order to verify the theoretical initial steps include the expansion of the existing ramjet combustion chamber test stand; expansion of a propelling nozzle test stand; improvement of compressor test stands at DFVLR and MTU to check out the critical high temperature fan; construction of a test stand to check out the hydrogen turbine; and construction of a test stand for the hydrogen/air-heat transfer mechanism.

In addition, there are test stands to check out materials, component cooling, and component stability. Some of the latter installations can be made available through the modification and expansion of existing facilities.

5.4.2 Hypersonic Wind Tunnels

The wind tunnels located at the DFVLR and the technical universities were all built in the sixties. Following the drastic reduction in hypersonic research programs in 1974, most of these facilities were decommissioned. Their reactivation cells for costly modernization of installation-specific components and in particular in the area of metrology and data processing. Given the present state of the art in data processing, there is also a lack of experienced operators and scientific advisers.

Hypersonic tunnels for airspeed simulations up to Mach 8 are needed to determine aerodynamic coefficients, partial loads, rudder strengths and pressure distributions as well as for propulsion unit integration and propulsion intake layout. The separation of the upper stage from the SAENGER lower stage also has to be verified by means of wind tunnel simulations. A general requirement is the most realistic possible projection of relevant Mach and Reynolds numbers as well as of heat transfer ratios and heat loads.

Since the existing facilities are first generation hypersonic wind tunnels, an evaluation must be made as to whether it is more cost-effective to build a new facility or to opt for possibly inadequate modernization; whether to switch to European or other foreign test sites, particularly if the sites are needed for just a few tests and for a limited time period and, finally, whether large-scale sites need to be developed as common European facilities at a later date, e.g., the German-Dutch wind tunnel (DNW) and the European Hypersonic Wind Tunnel (ETW) which is presently under construction.

5.4.3 Other Test Sites

A number of facilities are needed in the course of stage 1 of the program to check out materials/types of construction for the most part with regard to thermodynamic loads.

The planned enlargement of the IABG facilities to carry out thermomechanical load tests and thermoacoustic tests as part of the Hermes program for medium-sized and large structural parts satisfy virtually all the requirements of the hypersonic program.

5.4.4 Supercomputers

Given the present state of the art, the aerothermodynamic layout of a hypersonic flight unit can only be accomplished through a combination of experimental and analytical simulations. There is a need for significant computer capability in order to carry out analytical simulations of flow fields and thermodynamic effects up to and including gas kinetics. It would take presently available supercomputers, e.g., the University of Stuttgart's CRAY II and IABG/MBB's VP 200 some 300 to 500 hours to perform these computations. The layout of the propulsion unit (i.e., intake, engine, and nozzle) as well as special problems relating to airframe layout and structural optimization also call for significant computer capability.

Presently available supercomputer capability of up to 250 Mflops and storage location of up to 64 Mwords (64 bits) must be increased in the medium term to 1,000 Mflops and 256 Mwords (64 bits) and over the long term to 4,000 Mflops and 1,000 Mwords (64 bits). During a transition phase this can be achieved by coupling existing supercomputers; but over the medium and long term only through the establishment of a high performance EDP center which will also serve the needs of the hypersonic development program.

6. Implementation of Stage 1

The efficient use of available resources has a decisive bearing on the success of the hypersonic development program. This calls for proper structuring of separate program components and achieving the highest possible degree of cooperation. National cooperation within the program thus calls for exceedingly close interaction between the aerospace industry, the major research centers, and the academic community.

The following aerospace firms are primarily responsible for the hypersonic development concept:

Messerschmitt-Boelkow-Blohm Ltd. (MBB) and its subdivisions for communications systems and propulsion units (UK), aircraft (UF), and for transport and passenger airplanes (UT); Motoren- und Turbinen-Union, Munich Ltd. (MTU); Dornier Ltd. and Dornier-System Ltd. (DORNIER); and the DFVLR.

In addition, MAN Technologie Ltd. and KHD-Luftfahrttechnik [Aeronautical Engineering] Ltd. as well as electronics and equipment manufacturers and the chemical industry have indicated a desire to take part in the program. The materials industry will also be playing a major role in some individual programs.

IABG Ltd. of Ottobrunn will be responsible for conducting thermal insulation and component tests as part of the technology program.

The hypersonic concept is being supported by the BMFT. Coordination with the ministries of economics, defense and transportation and the coordinator for German aeronautics and astronautics takes place via the BMFT's interministerial coordinating committee on "aviation research and technology" formed in 1974.

The organizational structure for stage 1 of the hypersonic concept is depicted in Figure 9. If needed, it will be amended to meet subsequent program requirements. The responsibilities of the different organizational units are as follows:

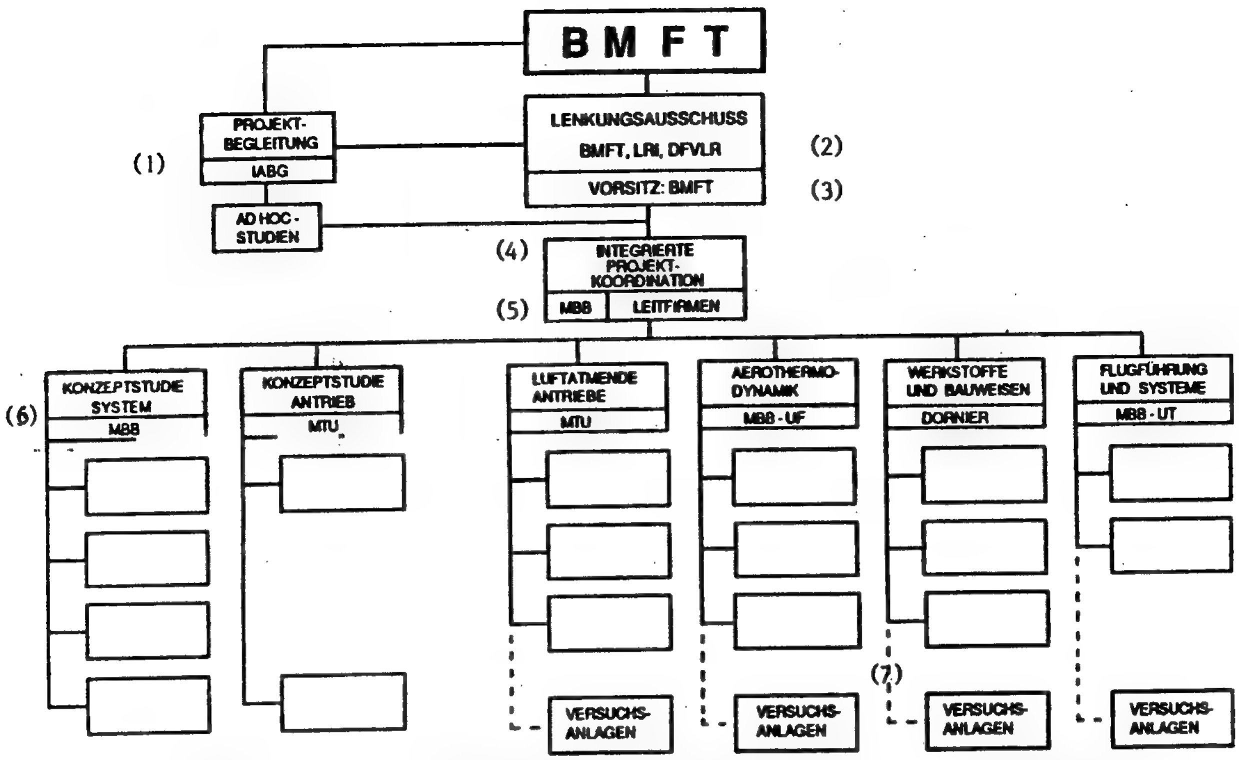

Figure 9. Organizational Structure

Key: 1. Project assistance—2. Steering committee—3. Chairmanship—4. Integrated project coordination—5. Primary contractors—6. Concept studies: system; propulsion system; engines; dynamics; materials/types of construction; flight control and systems—7. Test facilities

Coordination and direction of the hypersonic program is the responsibility of a steering committee composed of representatives of the BMFT, the aerospace industry and the DFVLR.

The steering committee evaluates the proposed technology programs, sets priorities and determines the allocation of funds. It may alter the objectives of different areas of technology and of individual technologies and may define supplementary ad hoc studies relating to systems and engine analyses. The steering committee is also responsible for coordinating plans for enlarging existing testing facilities and/or building new ones.

BMFT project monitoring has been assigned to IABG which assists the BMFT in the formation and implementation of the program.

Integrated project coordination is the responsibility of the main contractors (Dornier, MBB, and MTU) and the DFVLR. MBB-UK will serve as the overall coordinator. The main project coordination function consists in the coordination of the accompanying concept studies and the technology programs carried out by the main contractors with the appropriate testing facilities, i.e., the coordination and harmonization of individual activities of the various program participants.

If needed, the BMFT or the steering committee may call for ad hoc studies. Depending on the subject matter, the initiators of such studies will determine who is to be responsible for conducting them.

One of the main contractors, represented by a qualified project director, will be responsible for coordinating the work of the participating firms and institutions in the separate areas of technology, i.e., MTU, Munich will be responsible for air breathing engines; MBB-UF, Ottobrunn for aerothermodynamics; Dornier, Friedrichshafen for materials/types of construction; and MBB-UT, Hamburg for flight control and systems.

The technology-coordinating contractors may assist in defining and delimiting the functions of the participating firms and/or institutions, in coordinating areas of responsibility and setting priorities. They also coordinate the DFVLR's role in the separate technology programs. In addition, they define the testing facilities needed by the various specialized disciplines and coordinate the assignment of experiments to the DFVLR and IABG.

The above firms also establish and supervise the work of a support group made up of representatives of all participating firms and institutions. The technology-coordinating contractors are the representatives of the specialized area and, in particular, the results achieved on the steering committee. In the case of overlapping activities, e.g., the definition of test facilities, they coordinate their efforts with those of other technology-coordinating contractors.

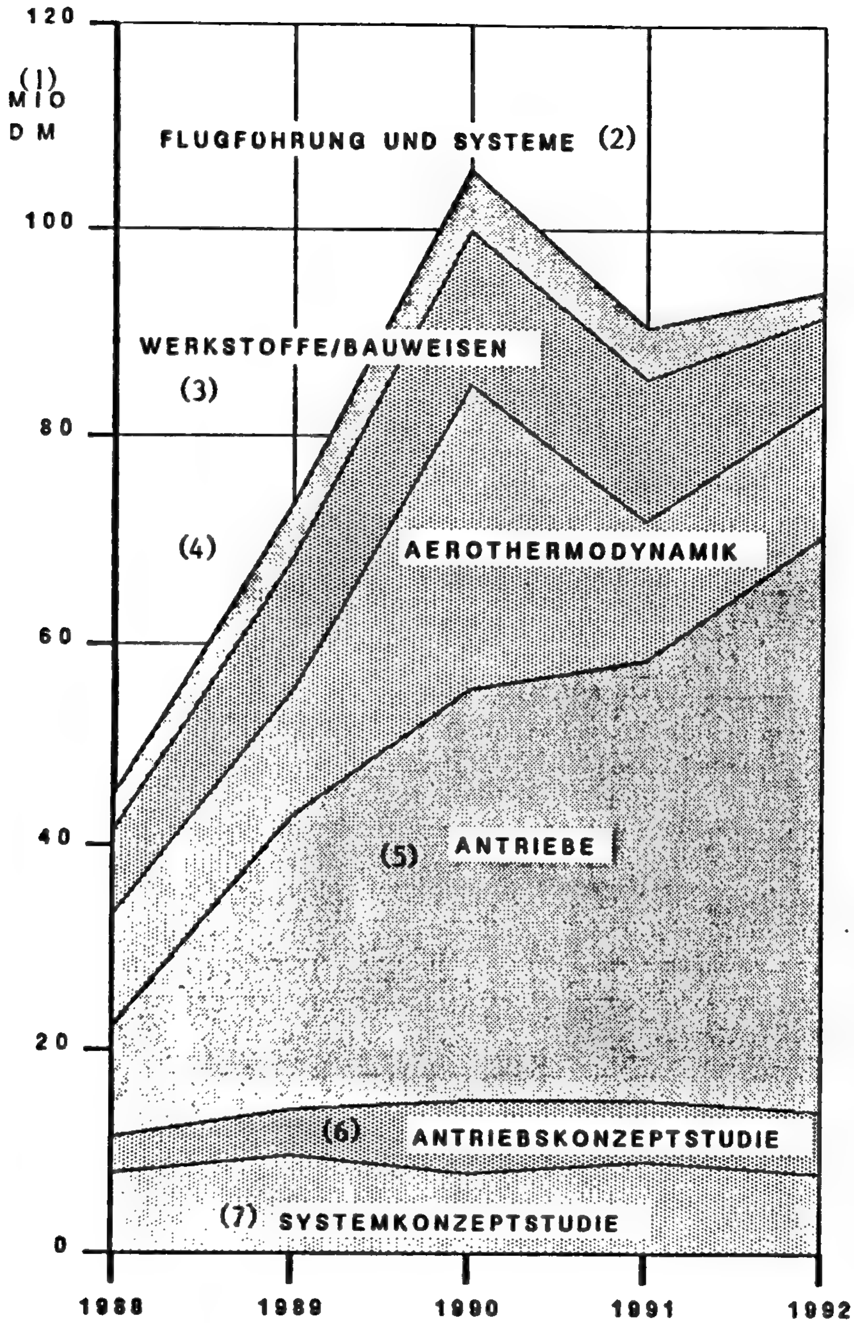

Figure 10. Stage 1 Total Cost (Concept Studies, Engine and Airframe Technologies, Not Including DFVLR Share in Basic Technology Research Program)

Key: 1. Millions of DM—2. Flight control and systems—3. Materials/types of construction—4. Aerothermodynamics—5. Engines—6. Propulsion system concept study—7. System concept study

7. Cost and Funding of Stage 1

7.1 Cost of Stage 1

According to industry estimates, the total cost for stage 1 of the development program will amount to DM 890 million, exclusive of the DFVLR contribution. In concentrating on the (top priority) SAENGER lower stage technology program, the cost can be reduced to DM 409 million. The costs are divided as follows: concept studies, DM 69.7 million; propulsion systems, DM 180.3 million; aerothermodynamics, DM 79.2 million; materials/types of construction, DM 57.4 million; flight control and systems, DM 22.3 million—for a grand total of DM 408.9 million.

The above figures for the various specialized areas for the period from 1988 to 1992 are listed in Figure 10. In Table 1 the various specialized areas are broken down according to studies, technology programs and equipment on a year-by-year basis. The figures include the proposed BMFT contribution in each instance.

The required promotional funds in support of the technology program differ from the total cost to the extent of the cost sharing by industry and the DFVLR contribution.

The total cost of DM 409 million reflects full implementation of concept studies and top priority technology programs, i.e., engine plus airframe, in the period from 1988 to 1992. Actual work on the program is restricted by the limitations on available funds.

7.2 BMFT Support for Individual Programs

The BMFT intends to provide up to DM 220 million to support work on stage 1, i.e., DM 20 million in 1988; DM 25 million in 1989; DM 45 million in 1990; DM 60 million in 1991; and DM 70 million in 1992.

In addition, it is expected that the BMFT will be able to contribute to the program by contributing research findings from its material research program.

The concept studies on the entire system and the engine to be commissioned are to be subsidized 100 percent while the individual technology program will be 80 percent subsidized.

The call for a 20-percent contribution to technology projects by industry is based on the expectation that they will substantially strengthen the technology potential for "classical" aeronautical products and other astronautical applications. BMFT promotional funds are to be used primarily for concept studies and propulsion technologies.

7.3 Basic Support by DFVLR

The DFVLR plans to contribute to the hypersonic program by extending basic (B) and yield-financed (Y) support in terms of providing personnel and investments. The following two tables list DFVLR contributions in millions of DM and man years.

		1988	1989	1990	1991	1992
Personnel	(B)	9.1	11.3	11.7	12.3	12.7
	(Y)	-	1.2	2.7	4.7	5.5
Investments		2.1	3.6	3.5	3.0	2.2
Total		11.2	16.1	17.9	20.0	20.4

		1988	1989	1990	1991	1992
Man Years	(B)	39	47	47	48	48
	(Y)	-	5	11	18	21
Total		39	52	58	66	69

7.4 Other Contributions

In addition to the contributions by the aerospace industry, other branches of industry, e.g., the electronics and chemical industries, have expressed interest in a participation in hypersonic development and have indicated their readiness to contribute substantial funds to the program. In the main, their interest lies in specialized areas such as flight control and systems as well as materials and types of construction.

As yet, the Deutsche Forschungsgemeinschaft (DFG) [German Research Federation] has not given final approval to the four special research projects proposed by technical universities in support of the hypersonic development program. It is expected, however, that they will be approved.

Table 1. Hypersonic Project Stage 1 Cost Breakdown (Not Including DFVLR Share of Basic Technology Research Program)

			1988		1989		1990		1991		1992		GESAMT	
(1)	● MITTELBEDARF													
(2)	◐ BMFT - ANTEIL		●	◐	●	◐	●	◐	●	◐	●	◐	●	◐
	STUDIEN													
(3)	SYSTEMKONZEPT		8.0	8.0	9.7	9.7	8.0	8.0	9.0	9.0	8.0	8.0	42.7	42.7
(4)	ANTRIEBSKONZEPT		3.5	3.5	4,5	4,5	7,0	7,0	6.0	6,0	6,0	6,0	27,0	27,0
(5)	TECHNOLOGIE-BEREICHE													
	ANTRIEBE													
	TECHNOLOGIE-VORHABEN		7,7	6,16	17,8	14,24	27,9	22,32	35,9	28,72	54,8	43,84	144,1	115,28
(6)	ANLAGEN	INDUSTRIE	2,7	1,35	5,9	2,95	5,0	2,5	5,0	2,5			18,6	9.3
		DFVLR	0,4	0,4	5,0	5,0	5,7	5,7	1,5	1,5	1,0	1,0	13,6	13,6
		RECHNER					2,0	2,0	1,0	1,0	1,0	1,0	4,0	4,0
(7)		SUMME	10,8	7,91	28,7	22,19	40,6	32,52	43,4	33,72	56,8	45,84	180,3	142,18
	AEROTHERMODYNAMIK													
	TECHNOLOGIE-VORHABEN		9,6	7,68	10,1	8,08	9,5	7,6	7,5	6,0	8,2	6,56	44,9	35,92
	ANLAGEN	DFVLR	1,4	1,4	2,5	2,5	1,3	1,3	0,6	0,6			5,8	5,8
		RECHNER					18,5	18,5	5,5	5,5	4,5	4,5	28,5	28,5
		SUMME	11,0	9,08	12,6	10,58	29,3	27,4	13,6	12,1	12,7	11,06	79,2	70,22
	WERKSTOFFE/BAUWEISEN													
	TECHNOLOGIE-VORHABEN		7,1	5,68	10,0	8,0	13,0	10,4	12,0	9,6	8,0	6,4	50,1	40,08
	ANLAGEN	INDUSTRIE	1,2	0,6	1,4	0,7	1,2	0,6	1,2	0,6			5,0	2,5
		DFVLR			1,45	1,45	0,65	0,65	0,2	0,2			2,3	2,3
		SUMME	8,3	6,28	12,85	10,15	14,85	11,65	13,4	10,4	8,0	6,4	57,4	44,88
	FLUGFÜHRUNG UND SYSTEME													
	TECHNOLOGIE-VORHABEN		3,61	2,89	5,14	4,11	6,1	4,88	4,95	3,96	2,5	2,0	22,3	17,84
	ANLAGEN													
		SUMME	3,61	2,89	5,14	4,11	6,1	4,88	4,95	3,96	2,5	2,0	22,3	17,84
(8)	GESAMTSUMME		45,21	37,66	73,49	61.23	105,85	91,45	90,35	75,18	94,0	79,3	408,9	344,82

Key: 1. Funding requirements—2. BMFT share—3. System concept—4. Engine concept—5. Technology areas—6. Technology program suppliers: industry, DFVLR, computers—7. Total—8. Grand total

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9. Abbreviations

AGV	Avion a Grande Vitesse [High-Speed Aircraft]
ART	Arbeitsprogramm Rueckkehrtechnologie [Return Technology Work Statement]
ATSF	Avion de Transport Supersonique Futur [Supersonic Transport Aircraft of the Future]
CARGUS	Cargo Upper Stage
HIMES	Highly Maneuverable Experimental Space Vehicle
HOPE	H-II Orbiting Plane
HORUS	Hypersonic Orbital Upper Stage
HOTOL	Horizontal Takeoff and Landing
Mflops	Mega Floating Point Operations per Second
NASP	National Aerospace Plane
OHR	Orientierungsrahmen Hochtechnologie Raumfahrt [Basic Guidelines for High-Technology Astronautics]

Report on Status of Airbus Industrie

MBB Seeks Larger Production Role

36980234 Duesseldorf WIRTSCHAFTSWOCHE in German 5 May 89

[Article by C. Deysson, W. Herz, W. Schmitz and B. Ziesemer; documentation by D. Petzold: "Will the Bird Fly?"]

[Text] Criticized as the original sin of regulatory policy and a bottomless pit for subsidies, blocked by cumbersome voting processes and regional egotism—the Airbus is still taking off: Long a success technologically, the Euro-jet is now to take off financially as well.

Every two days, a bizarre-looking giant aircraft lands at the Messerschmitt-Boelkow-Blohm (MBB) airport at Hamburg-Finkenwerder. The Super-Guppy, a super-transport costing about 60 million dollars, with the silhouette of a sperm whale, opens up its entire forward portion and swallows two fuselage parts, tail units or wings assembled at MBB for the Airbus, in order to bring them to Toulouse in France for final assembly. Later, each Airbus ready for flight will be flown back to Hamburg, where it will be fitted with the interior equipment ordered individually by each airline, in order to lift off again for Toulouse for delivery to the customers—one of the many peculiarities of the European commercial aircraft, which is being built jointly by companies in four countries.

If the Germans have their say, all of this will change after a merger of MBB and Daimler-Benz. MBB is asking its French, English and Spanish partners for its own final assembly line in addition to that of Aerospatiale in Toulouse, so that in the future it can deliver the Airbus directly from Germany to customers all over the world.

However, this does not just involve simple cost savings by giving up the time-consuming transportation back and forth, but national prestige: By doing this, the coordinator of the FRG's aeronautical and space flight industry, Bonn undersecretary Erich Riedl, would like to increase the "identification" of the public with the controversial aircraft project, which until now has cost the tax payers more than DM 5 billion in subsidies.

Not until the aircraft are assembled in the FRG, in the opinion of this CSU politician and eager Airbus lobbyist, will the impression be corrected that the expensive aircraft is a French product with a couple of German subcontracted deliveries.

The Airbus, not only the flagship of the new German aeronautics, space flight and armament group Daimler/MBB, but also a national symbol for the high technological capacity of the FRG?

There is no doubt about it: The bird that has been laboriously nursed for more than 20 years has taken flight. The Airbus has robbed its major rival Boeing of a part of its catch on the world market. To stop building aircraft in Europe, as was still discussed a few years ago, is no longer seriously under debate in the FRG today. What would be more natural than to present the technically successful superbird to the whole world as a symbol of "Made in Germany"?

Although the Germans, like French Aerospatiale SA, own 37.9 percent of the Groupement d'Interet Economique—the official title of the supranational consortium—until now the commercial aircraft have only been put together in France. But additional final assembly capacities are necessary anyway. A drastic increase in

orders, lengthening delivery times, and the expansion of the Airbus family by the A 330 and 340 long-range jumbo jets make changes unavoidable.

No wonder that Hartmut Mehdorn—head of MBB's Transportation and Commercial Aircraft business sector at Hamburg-Finkenwerder—envisions favorable conditions for a German advance. Being the key figure in the FRG as a member of MBB's management board and board of directors of Airbus Industrie in Toulouse, the fidgety 46-year-old is held to be the actual inventor of the final assembly idea. In his opinion, a German final assembly could save 150 to 160 million dollars a year.

But Mehdorn also knows: "In France the issue has an emotional background." On the new Airbus board in Toulouse, which began its work on 1 April, this German has so far met with unanimous rejection by the French and British. The MBB manager sees a chance for German final assembly only "if something happens on the political level."

The chancellor would very much like to take care of that. Helmut Kohl has already sent his Economics Minister Helmut Haussmann to the French government in order to present the German petition. But so far French Industry Minister Roger Faroux has merely permitted himself to give the noncommittal reply, that the Bonn people have "made their wishes known very clearly."

Although a decision about the German wishes is thus still open, there is heated debate in the FRG about the future location for final assembly: As an alternative to Hamburg the MBB general works council brought the Ingolstadt-Manching location into the discussion, where at present the Tornado fighter aircraft is being built. The groundwork has therefore been laid for a political conflict between the participating federal lands.

The back-and-forth about German final assembly is an example of the difficulties that have accompanied the Airbus project from the outset. Awkward voting processes between the four partner nations, regional and local egotism and non-expert political influence still burden their European aircraft construction today.

However, the German-French battle goes far beyond the usual wrangling about production shares, which took place at the beginning of each new model program. The debate about German final assembly marks a new phase in the conflict saga of the European Airbus cooperation, which above all reflects the increasing competition from parts suppliers from the Far East, particularly South Korea. Any one of the European and American manufacturers who has not assured himself of the most demanding work load for the next 10 to 15 years will hardly be able to compete with the rapidly learning engineers and producers in the Far East.

Large South Korean conglomerates such as Daewoo or Hyundai are now throwing themselves full speed ahead into aeronautics and space flight. In the future only those manufacturers who award subcontracts to local suppliers will be able to sell aircraft in that region. Above all in the assembly of relatively simple, labor-intensive components, such as aircraft tanks, the South Koreans are ruthless in playing up their cost advantages.

But rigorous cost management is necessary for the Airbus precisely if the entire project is to come out ahead at some time in the distant future—the present buying boom alone is not enough to bring the Airbus above the breakeven point.

However, at this time the economic environment is more favorable than ever for aircraft builders to attain this goal. At the moment all prognoses indicate that the need for airline traffic is increasing sharply; all of the major manufacturers anticipate annual growth rates of five to six percent until the year 2005. The cumulative need to replace scrapped aircraft takes care of additional demand. In the first four months of this year alone Airbus Industrie thus got 133 firm orders and 96 options—among them 100 firm orders and 70 options for the present money-maker, that is to say the 150-seat A 320.

Of this aircraft, which began delivery last year and which is regarded as the most modern machine at this time not only by Airbus market strategists but by the airlines as well, only four units a month can be completed: The European aircraft builders have been overwhelmed by the wave of orders.

It is primarily the internationally leading Airbus technology which has decisively contributed to the new distribution of roles in worldwide aircraft construction. The most recent example of this is a gigantic order for 308 airliners which the Irish GPA Group Ltd. leasing company placed in mid-April. To be sure, Boeing took the lion's share of the 17-billion-dollar value of the whole batch—182 jets at a total cost of 9.4 billion dollars. But the second largest share—4.3 billion dollars for 54 aircraft—went to Airbus Industrie. With 72 orders at a total value of 3.1 billion dollars, McDonnell Douglas got only the smallest share of the order boon. In 1988 alone 1,156 commercial aircraft were sold at a total value of more than 50 billion dollars—57 percent more than in the boom year 1987. Overall, the industry is now sitting on an order backlog of about 2000 aircraft. More than half of them are on Boeing's books, about one-fourth at Airbus and not quite one-sixth at McDonnell Douglas. All three companies must ask their customers to put up with long delivery times. "At the moment we could sell many more aircraft that we can build," Boeing director Raymond Waldmann complains, "and Airbus and Douglas are experiencing the same thing."

First of all, no end can be discerned to the hot market. On the contrary; both Boeing and Douglas recently revised their market prognoses upward. In a market study published in March, Boeing assumed that by the year 2005 8,417 commercial aircraft at a total cost of 516 billion dollars will be needed around the world. That is 22 percent more than the manufacturer had predicted a year earlier.

Boeing's market research director Jack Howard believes that the worldwide fleet of passenger aircraft presently numbering about 7,200 jets will grow to 11,800 aircraft in the next 15 years. "There are strong indications," says industrial expert Steve Binder of the New York brokerage firm of Bear, Stearns & Co, Inc., "that the present cycle will be of long duration—perhaps even the beginning of a new era in the aircraft industry."

But MBB aircraft builder Mehdorn doesn't yet want to use the term "new era." However: "Prices have already improved." As a "newcomer" they have almost "prostituted" themselves until now and have had to fulfill every equipment wish for the Airbus. "But now we will come closer to the Boeing system and offer only certain standard versions—with commensurate prices for special orders."

Further cuts in Airbus losses are now finally possible, in the words of the MBB manager: "We see light at the end of the tunnel." Mehdorn predicts that the entire program will break even as early as the mid-1990's, "if the dollar doesn't crash down on us again."

But the lean years are not yet over. The Airbus's deficit is programmed to grow with every signature on a sales order—despite the temporary cost-reducing effects of a larger number of units—since commercial aircraft are sold on a dollar basis because of the predominant position of the Americans. The costs, on the other hand, occur in European currencies, from which MBB in particular suffers due to the relatively stable Deutschemark.

For 1987 one used to say at MBB, according to finance chief Johannes Broschwitz, that every 10-pfennig drop in the dollar price below the calculated base represents a loss of about DM 100 million annually in Airbus business for the Deutsche Airbus GmbH subsidiary. Since the dollar exchange rate has settled on a level below DM 2, particularly the old A 300 and 310 models (priced between 60 and 70 million dollars), which can only be sold at no loss at an exchange rate of DM 2.40, are running up losses in the millions.

The A 320 is not faring any better (price about 35 million dollars), which was calculated at a minimum exchange rate of DM 2. Only the new A 330/340 versions, which with a price tag of 80 million dollars are the most expensive models of the Airbus family, are said by the manufacturer to be sold at a profit even with a dollar rate below DM 2. The losses for this "politically desired" aircraft, which in 1969, at the principal initiative of then CSU chairman and Federal Finance Minister Franz Joseph Strauss, was created through a German-French treaty, are distributed between the four participating companies. The final outcome, however, is that the billion-dollar amounts are largely assumed by the governments through guarantees, bonds, lost subsidies or direct offset of losses.

The first Airbus did not undertake its maiden flight until 1972, but "Airbus subsidies have been running since 1967," according to a reliable informant—the current president of the Federal Audit Office, Heinz Guenter Zavelberg, at that time working closely with Strauss in the Finance Ministry in Bonn.

And the Airbus is likely to remain a subsidy case for the present time. Not until the beginning of this year did the Federal Audit Office make a list for the Bundestag Economic Committee of the billions for the Airbus as well as of the "risks for the Federal budget until the year 2000 and perhaps beyond."

Until the decision in favor of merging MBB/Daimler, the Federal Government had already decided on a budget allocation of DM 10.7 billion: DM 6.7 billion in "conditionally repayable contributions to the development costs" for all Airbus models, DM 0.7 billion as a production grant for Airbus A 300/310, followed by DM 1.9 billion to repay the loan originally guaranteed by the government to finance series production, as well as DM 0.7 billion in installment sales financing assistance. To these are added other indirect subsidies, such as export guarantees, amounting to a total of DM 3.3 billion (1988 level).

In addition to this existing and continuing support, the takeover of MBB by Daimler-Benz will be further sweetened by additional Airbus billions. The federal budget for the current year already offered DM 254 million to compensate for the exchange rate. Precisely this exchange rate compensation could become expensive for the Federal Government in the following years: The government is prepared to pay up to DM 4,046 billion until the year 2000, if Airbus has to absorb declining sales revenue due to the sinking dollar price.

The Audit Office has further determined a series of other risks for the Airbus, which until now had not been considered by either the Economics Ministry in Bonn or by the industry in their planning—such as a "prolonged decline" in the dollar exchange rate even below DM 1.60. If the exchange rate drops by even 10 more pfennigs, it will result in additional costs of DM 2 billion for the A 330/340 model program alone.

In the opinion of the Frankfurt supervisors, for example a price war with U. S. manufacturers in the long-range market, reduced utilization of production capacity due to a drop in sales, or U. S. trade restrictions aimed at the Airbus, could turn into additional losses of several hundred million marks. This is because the gigantic U. S. market is particularly lucrative for all producers.

Whether the Airbus will get by entirely without subsidies at least in the distant future, has therefore by no means been determined. The Federal Government is hoping that joining the Daimler group with MBB will at least create the preconditions for it. With the new enterprise concept, it says in the cabinet decision of November last

year, "the responsibility for the Airbus program will gradually be transferred to the industry and thus in particular the necessary improvement in cost structure for aircraft development and manufacture will be achieved." And this hope is not unjustified: Daimler chief Edzard Reuter has given the chairman of the board of the new holding company Deutsche Aerospace AG, Juergen E. Schrempp, clear odds: Wherever possible to make aircraft production more profitable in the future.

This applies primarily to the future subsidiary MBB, where the present head of Dornier, Johann Schaeffler, is to take the helm. Attempts at obstruction by the public MBB partners Bavaria, Hamburg or Bremen relating to location or other questions of cost management, will no longer exist in the future: The MBB shares held by the lands will shrink by about 52 percent to 36 percent, and controlling minorities will largely be abolished.

Another important thing is: Aircraft construction will for the first time be put on an individual financial basis through the involvement of Daimler and the founding of Deutsche Aerospace. The purchase price in the amount of DM 1.7 billion, which the Stuttgart people have to shell out for their 50.01-percent majority of MBB common capital stock, will largely be "passed on to" the new Airbus corporation and used as capital resources.

Together with the cancellation of old obligations and the approved subsidies until final privatization of the Airbus in 11 years, the result is therefore an almost rosy financial picture from the viewpoint of the industry. MBB manager Mehdorn thus sees only advantages in linking MBB with Daimler-Benz: "For the first time we have a secure financial framework, and our position among the Airbus partners and vis-a-vis Airbus Industrie will be strengthened."

At the joint Airbus enterprise in Toulouse a new course is also being set by newly appointed supervisory board chairman Hans Friderichs. The former FDP federal economics minister has already arranged for a monthly meeting rotation by the AI supervisory board—the first outward sign that a new wind is blowing at AI. Under his predecessor Strauss the group met only once or twice a year.

But the conditions at the top were typical of the loose alliance of the "groupement," which functions mainly as a sales organization for the Airbus. For a long time no one actually made responsible decisions in Toulouse; no meaningful accounting system was in effect—and the sales prices were frequently negotiated totally without regard for the costs.

On the new seven-man Airbus board in Toulouse, where the four partner enterprises are now to be directly represented by the aircraft construction chiefs, financial director Robert Smith will be the principal one to take strong action. He has to see to it that the interrelationships among the four national companies and the central body will be made more transparent—including a uniform cost accounting. The simplest point for Airbus chief Jean Pierson: For cost reasons 20 percent of the subcontracts, which have been firmly allocated until now, will be resubmitted for bids among the partners.

Many problems that have occurred so far between Toulouse and the partners are no longer likely to occur. For example, until now the sellers, without checking with the manufacturers, promised their customers the most exotic interior outfitting at the standard price, or—much more seriously—they obligated themselves to the customers to deliver technical performance specifications, to which the industrial partners could not adhere.

Although the Airbus partners until now have shrunk from founding a genuine Euro-company, the chances are growing, through restructuring on the European and national levels, that the Airbus could finally become a success even according to economic criteria.

Technologically, it has been one for a long time, as even U. S. industry expert Paul Nisbet of Prudential-Bache Securities admits, not without envy: "It is correct that the Airbus would not have come into being without state subsidies. But that does not change the fact that today the Airbus is simply a better and more modern product with sophisticated technology." The U. S. aircraft industry, on the other hand, has not brought out a really new aircraft for many years. The Boeing jets are nothing but rehashed versions of older types. "When the prices for aircraft fuel go up again," Nisbet says, "then the airlines will deliberately look for a plane whose top technology makes more efficient operation possible."

That will be the time, at the latest, other market observers also say, when the Airbus will do really big business, even if the European aircraft should still be a little more expensive that U. S. machines. Nisbet, at least, already speaks of a deja-vu experience for the Americans: At first the three major auto manufacturers in Detroit laughed at the foreign competition, then they charged that it was dumping and finally they lost large portions of the market to them, because foreign passenger cars were simply technologically superior.

But if demand for the Airbus shoots up even more than now predicted, new production lines could be unavoidable in the short or long term.

And the strollers on the banks of the Elbe in Blankenese could possibly see the Super-Guppy land on MBB's airfield even more often; this time with parts from abroad for German final assembly.

MBB-Daimler Merger

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[Article by Bernd Ziesemer: "Fight for Ministerial Authorization"]

[Text] If the two FDP politicians Juergen W. Moellemann and Josef Gruenbeck in Bonn have their way, the merger of Daimler-Benz and MBB would still collapse at

the last minute. Helplessly their friend in the party, Federal Economics Minister Helmut Haussmann, had to stand by in recent weeks, as increasingly more top liberals publicly whipped up hostility against the marriage of giants. But the negative ruling by the Federal Cartels Office against the Daimler deal, which was delivered to the two companies in mid-April, can only be rescinded by means of a so-called ministerial authorization from Haussmann.

The objections of Cartels Office chief Wolfgang Kartte are primarily aimed against the concentrated market power which would result from a fusion in the armament sector. If it were just a matter of the Airbus, explained the chairman of the responsible decision-making department, Stefan Held, "we would have approved the merger in half a day." For even the Berlin officials assume that Boeing will continue to occupy a "dominant" position in the world market for commercial aircraft.

But the competitive disadvantages for the Airbus would "not be alleviated or eliminated" solely through the entry of Daimler, Held stated. A better organizational structure at Airbus Industrie, which the Stuttgart people have in mind, is "conceivable," to be sure. But that does not necessitate Daimler's involvement at MBB: After all, the Airbus partners have already begun to organize their enterprise in a more rational manner, independent of the merger.

Haussmann has been placed in a dilemma by the arguments of the Cartels Office and by demands from his own friends in the party: "Overriding national economic reasons"—the precondition for a ministerial authorization—argue in favor of a merger of MBB and Daimler only insofar as the Airbus is concerned. If it were just a matter of regulatory policy principles, the FDP politician would have to force the Stuttgart people largely to withdraw from the armament sector by imposing an order. But without that highly profitable business, it is not worth merging with MBB.

Daimler spokesman Matthias Kleinert understandably sighs: "Now suddenly everyone is coming forward and criticizing the merger."

Airbus Industrie Restructuring

36980234 Duesseldorf WIRTSCHAFTSWOCHE in German 5 May 89 p 52

[Article by Wieland Schmitz: "New Leadership Structure"]

[Text] A year ago the "four wise men," independent experts from the Airbus partner nations, delivered an a alarming report on the structural deficits of Airbus Industrie (AI) in Toulouse. They demanded a new leadership and administrative structure, which was to come as close as possible to a tightly organized corporation—proposals, which meanwhile have at least in part been put into practice.

AI, which will continue to function as an "economic association" according to French law, is to utilize the changes to gain in power and efficiency. A central point is the close personal interlinking with the partner enterprises. The supervisory board, on which previously 17 members from government and industry plus major staffs of advisers conducted long and unproductive discussions, has been reduced to five members. Chairman Hans Friderichs is joined by the chairmen of the boards of the four partner conglomerates as members—Henri Martre from Aerospatiale, Hanns Arnt Vogels from MBB, Sir Raymond Lygo from British Aerospace (BAe) and Javier Alvarez Vara from Casa in Spain.

The same setup is continued in the management—the board consists of Jean Pierson as chairman, already president of AI, and the four top managers of civilian aircraft construction at the partner companies: Jacques Plenier (Aerospatiale), Hartmut Mehdorn (MBB), Sydney Gillibrand (BAe) and Alberto Fernandez (Casa). They are joined by two employees from AI: Heribert Flosdorff as chief operating officer and Briton Robert Smith in the totally new key position of financial director. It will depend on his competence and ability whether the financial relations, until now obscure, within AI and between AI and the producing partners will be illuminated and checkable. Smith will not have the power and influence of a genuine corporate financial chief until the Airbus corporation is transformed into a real stock corporation—perhaps in the mid-nineties.

Airbus Industrie Competitiveness

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[Article by Christian Deysson: "Success on the World Market"]

[Text] The Airbus, which 10 years ago seemed no less exotic at U. S. airports than the French supersonic aircraft Concorde, by now has long since become part of the everyday scene at large airports from New York to Los Angeles.

Continental Airlines is only one of 12 North American customers who are presently flying or have ordered Airbuses. With 31 jets Pan Am alone has the largest Airbus fleet on the new continent. Pan Am recently traded orders and options for 50 model A 320 Euro-jets to industry colleague Braniff, not because it is less excited about the aircraft, but because of a shortage of cash. Ten years ago U. S. market leaders still ridiculed the European aircraft as an aeronautical cretin. But now their complacency is giving way to polite recognition. "The Airbus is very successful," admits Boeing's director for government relations, Raymond J. Waldmann: "The aircraft has fully proved its worth on the market." What's more, the Airbus has thoroughly upset the worldwide structures in civilian aircraft construction.

Fighting Hard to Catch Up; Aircraft Sales 1983 to 1988

	1983	1984	1985	1986	1987	1988
Airbus						
A 300 B4		7	14	3		
A 300-600		4	10	4	29	21
A 310-200/300	10	12	35	19	27	24
A 320		51	39	146	58	116
A 330*					12	3
A 340*					68	3
Total	10	74	98	172	194	167
Boeing						
B 737-200	44	22	30	12	13	
B 737-300/400/500	20	108	252	199	170	344
B 757	26	2	45	13	46	161
B 767	16	10	21	23	57	82
B 747	24	22	42	83	69	49
Total	130	164	390	330	355	636
McDonnell Douglas						
MD 80	43	117	106	127	133	186
DC 10	2	6	3	5	2	2
MD 11*					40	15
Total						

*Base contracts; Source: MBB

With an estimated market share of 53 percent (1989), Boeing is certainly still the world's largest civilian aircraft manufacturer, daily hauling out a new jet from its four giant production halls in and around Seattle. But measured by the 68-percent share with which Boeing imperially ruled the world market 10 years ago, the present position of the still largest U. S. export company already appears more modest. The lost percentage points went largely to the disagreeable European newcomer.

The McDonnell-Douglas subsidiary Douglas Aircraft Co., with a market share of 21 percent in 1988, did indeed rank ahead of Airbus Industrie (17 percent). But the Europeans could relegate the Californians, with whom a year ago they had negotiated without result about a joint aircraft project, to third place as early as the end of the year. "We do not talk about the competition," explains company spokesman Don Hanson, when asked about the advance of the Europeans on the U. S. market. But industry analyst Paul Nisbet of the New York brokerage house of Prudential-Bache Securities considers it "entirely possible that in the long run Douglas will be totally squeezed out of the civilian market by Airbus Industrie."

The former number three, Lockheed Corp., is already out of it. Its wide-body L 1011 TriStar jet is still flown by many airlines, such as Duesseldorf-based LTU. But the manufacturer retired into the armament industry years ago. The Americans have now even negotiated with Airbus—unsuccessfully to start with—about whether in the future they might offer their overcapacity from expiring military aircraft projects for service as subcontractors to the once derided competitor.

French Space Industry 1988 Exports Overviewed

AN890180 Paris LA LETTRE HEBDOMADAIRE DU GIFAS in English No 1488-1 bis, 27 Apr 89 p 1

[Article: "French Aeronautics and Space Industry Exports in 1988"]

[Text]

Orders Logged Outside of France

During 1988, direct orders logged outside of France came to a total of Fr 70.603 billion (excl. tax), compared to:

- 1987: Fr 47.447 billion excl. tax;
- 1986: Fr 39.880 billion excl. tax;
- 1985: Fr 61.448 billion excl. tax.

These figures only take into account firm orders and do not include options. As for equipment produced under international joint cooperation agreements, only that portion covering the French contract is given. This comes to Fr 37.251 billion, which is 52.76 percent of total orders. Breakdown by branch of activity is as follows:

- Complete airframes and aircraft: Fr 26.065 billion (36.92 percent), including Fr 16.024 billion in cooperation;
- Helicopters: Fr 6.662 billion (9.44 percent), including Fr 189 million in cooperation;

- Engines: Fr 21.282 billion (30.14 percent), including Fr 18.354 billion in cooperation;
- Missiles: Fr 6.049 billion (8.57 percent), including Fr 640 million in cooperation;
- Space: Fr 1.540 billion (2.18 percent), including Fr 545 million in cooperation;
- Equipment and electronics: Fr 9.005 billion (12.75 percent), including Fr 1.499 billion in cooperation.

Orders geographical breakdown is as follows:

	1987	1988
European Community	Fr 6.332 billion (13.34 percent)	Fr 10.904 billion (15.44 percent)
United States	Fr 13.843 billion (29.18 percent)	Fr 25.343 billion (35.90 percent)
Rest of world	Fr 27.272 billion (57.48 percent)	Fr 34.356 billion (48.66 percent)

Civil/Military orders breakdown:

- Civil orders: 65.23 percent;
- Military orders: 34.77 percent.

GIFAS Official Views French Aerospace Industry

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[Address by Jacques Savoyen, president of the GIFAS Equipment Group, at a press conference in Paris on 11 May 1989 concerning the upcoming Paris Air Show and the French military equipment industry]

[Text]

The French Aeronautical and Space Equipment Industry in the World

In the Western world, three countries have equipment industries [which] are capable of supplying all the needs of aeronautical and space programs: the United States, Britain, France—and to a lesser degree, West Germany. This is the touchstone for a major aeronautical and space industry, because, contrary to how things used to be, to build an aircraft today, there must be a permanent dialogue between the aircraft manufacturer and equipment manufacturers. Although the American industry is largest in terms of figures (approximately 70 percent of the total world market), the European industry, and especially, the French equipment industry, has often come up with highly original technical solutions. The A320, for example, is certainly the world's most advanced commercial carrier with its fly-by-wire controls and displays. The Rafale is the first aircraft in the world for which an official decision has already been made to develop a combat radar employing a two-plane electronic scan antenna. In the world lineup, the French equipment industry is on a par with Britain's industry, with approximately 7 percent of world activity.

The Equipment Group

The GIFAS Equipment Group has 155 member firms, as compared to 138 only two years ago. Thus, it is increasingly representative of the profession, especially since firms specializing in software have joined us. The equipment firms widely differ in size, technology and organization. Because of current market requirements, we are now witnessing a restructuring movement, to which I shall refer further on.

The Economic Situation

The French equipment industry has been present on the world marketplace for many years and today exports nearly 65 percent of its production, of which 33 percent is in the form of direct exports. Computed against purchases made in other countries by our airlines, the profession has a positive balance of payment of 10 billion francs.

Like the major prime contractors, the equipment industry is going through a rapidly changing economic situation: fluctuations in currency exchange rates, cut-backs in profit margins to remain competitive, technological transfers to customer countries, compensation contracts, market sharing under cooperation programs. In spite of all this, exports improved in 1988, and particularly with regard to orders.

Activities

The equipment profession must rebalance its markets: Military outlets are stagnating if not receding, while civil markets are in full expansion. Our profession is going through a drastic change. Consider that in 1987, 70 percent of business was accounted for through military contracts. Current orders suggest that we might see civil and military contracts balance within the next two years. The emerging civil market became apparent with the launching of the Airbus A300. At that time, several firms that had been having bad years with their civil productions decided this was the time to place the accent on civil. Here was a product that would enable them to recoup past investments while expanding production. But there were still many problems to be faced, such as how to offset fluctuations in the dollar, which, in dropping, carried away profits. In the military field, although current programs seem to be running out of steam, research and development is expected to surge, especially in conjunction with the Rafale and HAP/HAC programs, thereby creating plenty of work for our engineering departments. France's five-year plan, now being revised, is not expected to affect these programs. Nevertheless, the profession remains vigilant, as schedules can still be manipulated. Large-scale production is being planned for many programs scheduled to see the light during the final years of this century. This means we will have to wait a long time before obtaining a return on investment. It is by no means certain that there will be a market for present programs, even updated. It should be

realized that for some equipment manufacturers, a retrofit program, especially when involving weapon systems, is really no different than launching a completely new program. The profession might derive greater advantage from retrofit programs than in the past. Foreign customers are expected to favor these programs. They would hesitate to invest in completely new airframes when the old ones might be given a few more years of service with a retrofit. The profession should analyse this market carefully, bearing in mind the difficulties involved, because only the most solidly established equipment manufacturer will be able to engage in what are veritable partnerships with the customer. Space is not yet a significant activity for our profession (around 6 percent), but in the past 3 years, activities have more or less doubled. Important programs have been launched: Hermes, Ariane 5 and Columbus. It might be thought that here would be a great chance for our industry. Unfortunately, however, French prime contractors are handling such a large portion that French equipment manufacturers are left in a position unworthy of their competences. During the prediscussion phase, French equipment proposals were usually classed technologically in first position. But alas, few contracts were awarded because this would make the French contribution too large. Less competent industries in other countries will rejoice.

The 1988 Final Report

To date, we only have estimated results for 1988. **Personnel** At the end of 1988, personnel stood at 35,500 persons, a slight drop against 1987. **Turnover** Turnover was Fr 23,000 million, a drop against 1987. Breakdown of the figure is as follows: military, 64 percent, of which 9 percent for missiles; civil, 36 percent, of which 6 percent for space.

Turnover for direct exports, however, increased by 9 percent and in 1988 represented approximately 35 percent of total activities, against 27 percent in 1987. **Orders** Orders representing Fr 25,800 million were booked compared to Fr 21,600 million in 1987. Civil orders have grown significantly (38 percent more than 1987), while military orders slowed (up 10 percent). Export orders represent 32 percent of all orders booked. Pending orders to be filled are 12 to 15 percent better than 1987. These figures indicate that the profession is slowly moving forward, with military activities still dominent. The export policy adopted around ten years ago (in 1976, exports represented barely 10 percent of activities) and an expanding civil market have been welcomed, as these two poles of activity are sources of progress for the profession. It should not be thought that military orders are finished. A recovery is expected in the coming 5 or 6 years when new programs arrive at production stage.

Three Important Cards—Methods

It has long been said that one advantage our industry enjoys over American industry is that it knows how to handle small production batches. This remains the case, although with certains programs, we have reached production rates that are fully comparable to American figures. Major examples are the civil programmes A320 and ATR 42/72.

—Technology—Our equipment firms have always placed great stress on research. Today, this is more than ever the case, with the preparation of new military programs (Rafale, HAP/HAC, NH 90 and missiles) and civil programs (A330/A340, ATR 72) which will create new generations of equipment. Today, technological efforts are being maintained, although government subsidies for military research are being cut back (now 35 percent against 50 percent formerly) and are practically nonexistent where the funding of civil research is concerned. Today, over 10 percent of turnover is ploughed under for auto-financed research.

—Commercial—The export performance of the various firms shows that the equipment industry has maintained if not improved its competitiveness against major rivals. The goal of the firms has been to work with a dollar at 6 francs, although its real value is above 7 francs. This goal has been achieved thanks to extensive improvements in production made in recent years. The product support services of French manufacturers, except for a few snags also encountered by manufacturers in other countries, have, in the opinion of operators, been of the same level as the services of competitors. The excellent service available for the Airbus, including the A320, recently delivered to Pan Am and American Airlines illustrates this point, as no criticisms have been received from these two exceptionally demanding airlines.

Cooperation—European Cooperation

European cooperation has become a necessity within the present context of escalating programs. This need is not dictated by technical considerations, as the French industry is capable of supplying all equipment for all aeronautical and space programs. Cooperation, especially on the European level (notably, Franco-British and Franco-German), has been our policy for a long time in military programs. Cooperation is also the key to the Airbus program. Relations between French firms and those of other European countries are now excellent. This has not always been without problems, because cooperation means work sharing and hence know-how sharing, and the technically stronger partner is always the loser in such arrangements, as he gives more than he receives. Today, European cooperation extends well beyond the simple sharing of tasks within a program. We are now seeing research programs extended to European cooperation level, especially within BRITE/EURAM for civil research. Simultaneously the military EUREKA project is starting to materialize. The trend is to establish joint research funds, and this idea will no doubt soon become a reality. **Worldwide Cooperation** Besides the traditional partners of our industry (USA, Brazil, India, East Bloc countries, etc.), the GIFAS Equipment Group

is now moving towards the Franco-Indonesian Aeronautical Equipment Association (FIEA), assigning a permanent delegate to South-East Asia. Negotiations are now in progress with Japan and perhaps Taiwan. On the subject of the USA, GETECA, an outgrowth of the Equipment Group, has, in the past year or so, opened a second office at Seattle. This will make it possible for the joint holding company to conduct promotion work aimed at the major American aircraft manufacturers, especially Boeing, McDonnell Douglas, and Lockheed.

Reorganization Within the Profession

During the past decade, the work methods of our firms and the way programs are funded have changed considerably. The equipment industry is well aware that it can no longer be satisfied with the methods of yesterday. Four basic factors must be taken into consideration:

- the technological breakthroughs of recent years and the scope of financial investment needed to keep abreast;
- the need to participate in all major programs, as exclusion from one might lead to a lasting loss in knowhow;
- the need to eliminate all duplication in research and development while increasing market portions to amortize long production schedules;
- the ideal financial dimension for maintaining mastery in systems and remaining in a position to dialogue with those giving the orders. Today, it is imperative to be amongst the world leaders in each specialization. This is why the old, once efficient structures must now be thought out anew. Consequently, the French equipment industry is in a period of structural change. The first mergers have already been made (Turbomeca, Aerazur) and others are in progress (Aerospatiale - Thomson-CSF).

Conclusion

The French equipment industry is at a crossroads, technologically, structurally, and in other ways. Its expansion rate, now modest, will increase with the growth in civil programs. Military activities may be expected to pick up significantly in the next 5 or 6 years when production starts on new programs. Only a truly dynamic industry is capable of fully rethinking its basic structures. The challenge taken up by the equipment manufacturers is important because, like the motorists, they are an indispenable part of a great aeronautical and space industry, ever jealous of its ability to make decisions independently.

BIOTECHNOLOGY

FRG: BMFT Subsidy of Industry R&D Discussed

MI890263 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in German No 501, 18 Apr 89 pp 3-4

[Text] The indirect-specific program for subsidizing the biotechnology industry, started in 1986 and due to end on 31 December 1989, has provided effective support for the development and application of new biotechnology methods in medium-sized industrial companies, stated Dr Albert Probst, parliamentary secretary to the BMFT [FRG Ministry of Research and Technology].

To date, over 230 company research projects have been financed with almost DM70 million by the BMFT. More than 50 projects have already been completed.

The percentage of projects from small and medium-sized firms is encouragingly high: about 90 percent of the applications come from firms with less than 500 employees. This makes biotechnology's attraction and broad applications potential clear.

About one-quarter of the subsidized firms had their first contact with biotechnology issues through these indirect-specific measures. Most firms are still very young: about half of them were founded since 1980.

Most of the subsidized firms are part of the chemical or mechanical engineering industries. For example, a small firm with four employees is developing a cell population analyzer that can be used to make qualitative and quantitative predictions about the conditions of large cell populations, e.g. in cell cultures. In another project, a medium-sized company worked with the European Molecular Biology Laboratory (EMBL) in Heidelberg on developing a peptide and DNA synthesizer.

Several horticulture firms are also taking part in this program. Twenty-two such companies are now applying modern cell culture technology instead of conventional cultivation and propagation methods. Thus a horticulture company in southern Germany is receiving subsidies to build an industry-wide in-vitro station (for propagation by cell culture). The company's knowledge works directly to the advantage of the 21 associated seed-growing companies.

Firms specializing in problems or production processes in environmental protection or technology have developed and applied new biotechnology processes with the financial support of this indirect-specific program.

Applications are still being processed for about 40 projects totaling about DM10 million. Dr Probst pointed out that the application deadline for this program was 15 February 1989, since the satisfactory implementation and administrative conclusion of biotechnology projects takes about 9 to 12 months.

COMPUTERS

European Consortium for Computer Science R&D Established

MI890267 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in German No 501, 18 Apr 89 pp 13-14

[Text] Computer science researchers from the FRG, France, and the Netherlands have decided to join efforts to intensify their scientific activities.

The Center for Computer Science (CWI) in Amsterdam, the Society for Mathematics and Data Processing (GMD) in St Augustin, a major research organization supported by the FRG Ministry for Research and Technology (BMFT), and the French National Institute for Research in Computer Science and Automation (INRIA) in Rocquencourt signed a cooperation agreement on 13 April 1989 at the GMD.

The agreement is a response to both the European single market in 1992 and to worldwide competition. By combining resources, the competitive position of European computer science research should improve relative to the United States and Japan.

In the future, computer science researchers will focus primarily on those research areas that are of special concern to Europe. Planning includes basic research in computer science, information technology, and mathematics, as well as development projects and applications with partners from industry, universities, and other organizations. The special resources and advantages available at each of the three national research establishments will be exploited and their experts will develop new European research programs and make appropriate proposals to their governments.

The following activities are also planned:

- Current issues in computer science and mathematics in Europe's research policy will be made public.
- Joint long-term, strategically significant projects will be considered. International meetings to discuss key questions in computer science and mathematics will create greater mutual understanding. Seminars and working meetings of small groups should help improve cooperation among individual scientists in specialized areas.
- Improved cooperation in current day-to-day work will be achieved by exchanging scientific results, literature, and by exchanging scientists, especially through scholarship programs for young scientists, and by developing a computer network. Finally, the training of scientists will be intensified.
- A joint quarterly newsletter will help improve communications between the scientists from the three organizations. The newsletter will also inform the interested specialist public about group activities.

CWI, GMD, and INRIA consider themselves to be a European computer science and mathematics research consortium. They work as central national research institutes in basic research, applied research, and development in the Netherlands, the FRG, and France on behalf of their respective governments. They follow developments to the point of applying computer science achievements in industrial settings. Together they represent an annual budget of ECU130 million (approximately DM260 million), with a total of 2,400 employees including 1,000 scientists.

ANNIE Project Participants Noted

AN890184 Paris FRENCH TECHNOLOGY SURVEY in English May 89 p 1

[Article : "ESPRIT Programme on the Applications of Neural Networks for Industry"]

[Text] The Engineering Industries Research Center (CETIM) is participating in the ANNIE programme (Applications of Neural Networks for Industry in Europe). ANNIE began in November 1988 and will cost $6.5 million over an initial period of 3 years. Funding is provided partly by the Community ESPRIT programme, the remainder being funded by the industrial partners. The project is managed by the Harwell Laboratory of the United Kingdom Atomic Energy Authority. The other partners are British Aerospace and Artificial Intelligence (UK), IBP Pietsch, Siemens, and KPMG (FRG), Alpha (Greece), and finally the Universities of Athens and Darmstadt (FRG).

The objective of the ANNIE project is to compare the approaches using neural networks with the more conventional methods, such as shape recognition, optimisation, instruction theory and so on. For this purpose, methods will be tested on real industrial problems in automatic process control, robotics, non-destructive testing and more generally in instrumentation.

It is planned to hold seminars in the different Community countries during the final year of the project in order to bring the capabilities of the systems to the attention of industry.

Status of FRG R&D Artificial Intelligence Assessed

MI890261 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in German No 500, 31 Mar 89 pp 7-8

[Text] The possibilities for enhancing information processing with systems using artificial intelligence have set considerable research activities in motion in industrialized countries all over the world, especially as these systems have generated great market expectations.

The FRG Minister of Research and Technology has accordingly strengthened basic research and development: since 1984, joint artificial intelligence projects have been financed to the tune of DM160 million. An FRG Artificial Intelligence Center (DFKI) has started working in Kaiserslautern and Saarbruecken. The DFKI was founded as a limited liability corporation (GmbH), its majority shareholders being industrial companies which can immediately adopt the results of research and develop them further with profit. The DFKI carries out long term, targeted, basic research on artificial intelligence, which is financed in the long term (10 years) by

the BMFT [FRG Ministry of Research and Technology], project by project. Now that the planning period has been concluded, the first major longer-term projects are being started.

Initiatives of the Organization Center of the Economic Congress (OFW) are also aimed at reinforcing collaboration between science and industry in this field.

The tasks that the OFW has set itself include:

- Creating a basis for communication between industry and students;
- Identifying and discussing the technical requirements of the future in a timely manner;
- Provide a stimulus to artificial intelligence as a scientific discipline by helping to ask the right questions and work out new answers.

The debate on the opportunities and risks of artificial intelligence will be created by science itself during its assessment of the consequences of this technology. Some essential points illuminate the urgency of this assessment:

- Experts estimate that some 1,000 expert systems are being developed in the FRG; 200 are ready, but only 25 to 30 have been installed so far;
- The main tasks of expert systems are diagnosis (25 percent), configuration (20 percent), planning (17 percent), and consultancy (16 percent);
- There is evidence of a dynamic market development. The market for expert system software has expanded from DM70 million in 1985 to DM260 million, while the full market potential is expected to open beginning in 1990;
- Industry is the predominant user, accounting for more than 80 percent all over the world, followed by banks and insurance companies with 8 percent;
- Production (38 percent) and distribution (28 percent) are the primary fields of application.

Discussions regarding the assessment of the consequences of this technology revolve around the following questions:

- Are expert systems contributing to any changes in the structures of responsibility, or in the division of roles between man and machine?
- Do they involve any erosion or loss of human experience and know-how in the workplace?
- What are the criteria governing the use of expert systems in fields where security is important?
- Does the FRG legal system make adequate provision for any liability problems that might arise?
- To what extent can artificial intelligence methods and systems imitate any substantial part of human intelligence and creativity?

FACTORY AUTOMATION, ROBOTICS

France: Advanced Machine Vision System Developed

AN890186 Paris FRENCH TECHNOLOGY SURVEY in English May 89 p 19

[Article: "Computer Assisted Inspection and Measurement]

[Text] The "Visiflex" line of industrial vision systems, developed by the Technicome company, is designed around a card characterized by its compactness (single card measuring 360 x 340 mm) and its considerable flexibility as regards system configuration and application.

A Visiflex machine can handle a wide range of automatic inspection tasks on production lines by means of a large number of application packages. These applications include the following:

- object tracking operations by location and measurement,
- analysis of defects concerning appearance, shape, and so on,
- recognition of alphanumeric characters under difficult conditions (poor images).

Visiflex is ahead of other systems in:

- Intelligence, as characterized by its tolerance to non-linear variations in lighting and contrast, poor image quality, and positioning errors;
- Speed: Processing of shape recognition and interpretation operations takes less than 1 second;
- Precision: The camera field of view is processed at subpixel precision levels (1/2,000).

MICROELECTRONICS

Sagem, CNET Start Up Flat Screen Plant

AN890132 Paris ELECTRONIQUE HEBDO in French 30 Mar 89 p 11

[Article: "CNET Improves Links With Industry"]

[Text] The National Center for Telecommunications Studies (CNET) signed 85 licensing contracts in 1988 versus 36 in 1984. Its goal is to better utilize the expertise that can sometimes have applications beyond the communications.

With a 1988 research budget of Fr 1.713 billion, CNET's primary role is to serve as the technical and research center of France Telecom, of which it is an integral part. Nevertheless, the transfer of its technical expertise to industry is one of its major goals, since it constitutes a significant complementary implementation of the investments and the effort expended. In 1988, CNET devoted 3 percent of its resources to technology transfers

to industry, an activity that now employs 120 people. In 1988, sales of licenses and the resulting profit-sharing registered by industry amounted to Fr 11 million. It is not much, but the figure is steadily growing—it was Fr 7.5 million in 1984. In comparison, 85 licensing agreements were signed in 1988—51 with small and medium-sized enterprises (SMEs)—versus 36 agreements (18 with SMEs) in 1984. The improvement is significant.

From Sale of Licenses to GIEs

Since 1985, about 110 patents have been filed each year in France. During the 1979-84 period, the figure was 77. That means that CNET was able to increase its effective intellectual productivity by 50 percent in 10 years—not an unusual achievement. On the other hand, it sells its expertise far more effectively than in the past.

At a press conference held on 23 March in Paris, CNET industrial relations officials reiterated their philosophy of cooperative activities. "Our expertise has taken the form of patents, software, and know-how for public networks; however, it can also impinge on other sectors, such as microelectronics, information science, and visual display technology. We are seeking primarily French partners for our technology transfer arrangements. However, we will not rule out European, or even non-European partnerships, if French companies are not interested or if they feign interest to hinder our progress."

Technology transfers are carried out in the form of licensing contracts, cooperation agreements, or GIEs (Economic Interest Groups). Licensing agreements are generally not exclusive. Financial considerations are an important aspect of the negotiations.

Cooperation agreements relate to the extension of the "major CNET multiyear projects," of which 12 are underway. CNET hopes that a partnership can be formed as soon as possible, "because an attempt to transfer everything 'in one piece' just will not work; the transition is too difficult." The last type of transfer is the Economic Interest Group (GIE). This arrangement, which, for example, was used with Sagem for the development of flat screens, is justified by the fact that all the preproduction stages must be mastered before ascertaining whether or not CNET's expertise can be profitably employed in industry. Once success has been achieved, CNET can withdraw from the operation (but France Telecom can take over if it deems it useful to do so).

Generally, finding a partner does not seem easy: "Companies must be found that are willing and able to make a commitment to these projects. For example, we still have not found a company interested in collaborating with us to develop a design-oriented workstation for signal processing applications."

[Box] Sagem/CNET Flat Screen GIE Is On Track

As planned, last December Sagem [Company for General Electricity and Mechanics Applications] and CNET set up, without fanfare, a 50/50 GIE, dubbed "Planecran," whose purpose is to produce liquid-crystal, active-matrix flat screens in small quantities, but using industrial production methods. The primary aim is to ascertain whether CNET technology can be used on an industrial scale to produce flat screens at a price that is acceptable to the international market.

Thus, a pilot plant staffed by Sagem employees that is capable of producing hundreds of screens per month is being set up at Lannion. It is being built at Sagem headquarters in the Paris area by laboratories responsible for all elements apart from the screen—i.e., lighting, the control circuit, and assembly. Although the parameters of the flat screen have been more or less defined, this has not prevented CNET from pursuing its research outside the GIE. CNET is especially interested in polycrystalline silicon; this could make it possible to integrate the control circuit onto the screen itself. It should be pointed out that the screen that is currently in the preproduction stage uses amorphous silicon, which requires only two masking steps—an economical procedure. The plant's initial production run is slated for the fall. Black-and-white screens for telecommunications and data processing applications will be followed by simple color screens, for videophones, for example. Sagan will probably decide whether or not to go ahead with full industrial production during 1990.

UK Funds Optoelectronics, Information Engineering Programs

AN890189 Chichester EURO-TELECOM in English 5 May 89 p 5

[Article: "Government To Fund Information Technology and Opto-Electronics Research"]

[Text] The British Government is to allocate a total of 43 million pounds to two strategic areas of information technology research, optoelectronics and "information engineering," during 1989. Two initiatives with funding of 22 million pounds are to start immediately.

In optoelectronics, 15 million pounds has been allocated to the LINK Optoelectronics Systems programme, which will replace the earlier Joint Opto-Electronics Research Scheme (JOERS), due to be completed this year. The Department of Trade and Industry is to provide 10 million pounds and the Science and Engineering Research Council (SERC) 5 million pounds.

A new information engineering research programme called IEATP—Information Engineering Advanced Technology Programme—is to be funded with 7 million pounds of the DTI's money and a further 2 million pounds from SERC. Later in the year an additional 20 million will be made available for the IEATP.

The LINK programme will comprise a portfolio of industrial and academic collaborative projects, which will concentrate on optical communications systems and subsystems and on optical information processing. According to the DTI, the programme is designed to "move the UK towards optoelectronic system integration and eventual commercial exploitation" by encouraging essential materials, component and device research. "Some projects will culminate in carefully chosen laboratory-based demonstrators covering a variety of systems environments," according to a DTI spokesman.

Already more than 900 applications have been received for funding under the IEATP, which will support 100 projects. "About 50 percent of the successful collaborative projects include small firms, and nearly half of the companies involved are joining such projects for the first time," according to Lord Young, secretary of state for trade and industry. He added that he "looks forward to the next call for applications due later this year" when another 20 million pounds will be available.

Fields covered by the scheme include advanced semiconductor devices, systems architecture and system engineering. It will include about 80 industrially led projects and a further 25 academic projecs with "industrial potential." Around half are concerned with systems engineering, the remainder with system architecture and semiconductor devices. In addition to this national research effort, Lord Young pointed out that the UK is contributing "about 200 million pounds" to the European Community's ESPRIT II programme.

Siemens Strategies for Increased Competitiveness Discussed

Acquisitions, Restructuring

36980235 Munich INDUSTRIEMAGAZIN in German April89 pp 26-34

[Article: "The Giant Flexes Its Muscles"]

[Text] Siemens— Profitable long-term contracts with government agencies have made the German electronics giant smug and tired. However, the time of court purveyors has come to an end: national markets are becoming more transparent, international competition is getting more intense. Solid and conventional Siemens AG is facing the changes with unusual energy.

The commercial is both trite and convincing. On the TV screen, a cargo port, obviously in the United States, with containers bearing the name "Siemens". A sonorous voice explains: "You won't believe it, these are not shipments from Germany. These are products 'made in U.S.A.' going to Japan."

The German electronics company has been showing this TV-commercial to U.S. households during prime time since October of last year. Europe's industry leader in the world's largest electrical/electronics market is largely unknown to the general public. Even with sales of $3.1 billion or almost 10 percent of total sales in the United States in 1988, the time-honored Munich company has a market share of only one percent.

In Great Britain, the market share of the German electrical giant is not much better. An office in Sunbury-on-Thames near London has sales of only about DM1 billion, which translates into an equally insignificant market share: a negligible one percent.

Even in France with a sales volume equal to that in the United Kingdom, the Munich company holds only a secondary position. Sales of DM1 billion in France translate into a market share of only one percent.

Siemens does business in 123 countries - with light bulbs and irons, computers and lithotripters, nuclear plants and microchips. Hardly any other company in the world has such a broad product line and produces almost everything that has to do with electrical engineering and electronics, from products costing pennies to projects costing several billion.

Still, Siemens is really strong only in its domestic market. The Federal Republic accounts for more than half of its sales of DM60 billion, the rest of Europe for another 25 percent—with France and Great Britain the weakest markets. The rest of the world, including North America, accounts for the remaining quarter. As a Siemens director stated, "we have a large market share in small countries, and a small market share in large countries."

If CEO Karlheinz Kaske has his way, this situation is to change soon—primarily by taking over companies or—if this is not possible—through joint ventures. With a cash reserve of DM24 billion, Kaske who is usually rather restrained strikes a new note: "We will capture any ship which passes us."

This is essential if he wants to reach his ambitions global goals. In the long run, Kaske wants the U.S. to account for 25 percent of sales, and he wants to at least triple sales in France and England.

The electrical/electronics company which was once ridiculed as being a sleeping giant is flexing its muscle, is hungry—and on the attack. As Hermann Franz, management board member in charge of strategic planning, predicts: "In five years, Siemens will be a different company, and will be one of the most aggressive in Europe."

The company which previously has been administered rather than offensively managed, is undergoing comprehensive reforms led by Kaske to bring it more in tune with market needs. Kaske sees these changes as part of the general forward strategy of the company, since the switch from electrial engineering to electronics will change the world market dramatically. Chips can be used

universally, they are not blocked by national standards as is conventional technology such as counters, connectors, motors, telephones and other systems.

On the other hand, the various governments are about to reduce economic barriers and open the national markets some of which are still highly protected. For instance, the EC-commission in Brussels ordered the postal services of their member countries to admit foreigners to their telephone and telecommunications business.

Siemens which has received long-term contracts from the postal and railroad services, from the Bundeswehr and the state police is entering both a new and rather difficult time. The previous official contractor must face the worldwide strongest competitors both internationally and nationally: AT&T in telecommunications, IBM for computers, and General Electric (CGE) in energy and automation technology.

Kaske knows the strengths of his competitors. He also knows that he cannot compete if he maintains the leadership structure which is 20 years old and rather antiquated. Together with chairman of the board Heribald Naerger, finance chief Karl-Hermann Baumann and strategic manager Hermann Franz (Siemens jargon: "the gang of four") he started the first reorganization phase last October. The eight company divisions which are each headed by management board members are being converted to 15 smaller profit centers with only a unit head in charge. As part of the reforms, the large management board (28 members; last year 31), wil be reduced drastically.

Kaske does not yet tell who has to go. He will wait until the meeting of the board of directors on July 5 before he tells his colleagues who has to go—in itself strong medicine for Siemens.

Despite all secrecy, the management structure is already becoming quite appearent. In addition to Kaske, the heads of the six corporate business divisions will remain, in addition to three division heads who will be responsible for five of the 15 new business units each, so that possibly only 10 of the 31 board members will remain: —Karlheinz Kaske, CEO —Corporate Divisions —Karl-Hermann Baumann, Finance —Hans H. Schlitzberger, Personnel —Hermann Franz, Corporate Planning and Development —Hans Guenter Danielmeyer, Research and Development —Claus Kessler, Production and Logistics —Hans-Gerd Neglein, Regional Planning —Business Divisions (The new organizational structure will have 15 business units; management board members Vogelsang, Baur, and Barthelt will be responsible for five of these business units each.) —Hans Guenter Vogelsang, Energy and Automation Technology —Hans Baur, Communications and Safety Technology —Klaus Barthelt, KWU

Organization of Medical Technology Area as a Model

The decision to decentralize marketing and production and assign it to the various units is no less revolutionary. This will give the whole company an impact it already has in medical technology. Without slow central marketing as a cumbersome intermediary, this division was free to do what it wanted from the very beginning—and with remarkable success: in the medical field, Siemens has advanced to the top position worldwide.

The organization of the medical unit serves as a model for the other units. Proven in the hotly contested markets, the Siemens medical technology managers demonstrate how the classical government contract areas will have to function one day under liberalized market conditions.

Another event which was unthinkable in the 141-year history of the company until now shows how far Kaske has brought the company: the hostile takeover bid against British Plessey plc in cooperation with General Electric Company (GEC).

Against the express wishes of the management in Millbank Tower and the minority shareholder and chairman John Clark (62), the British and German number one companies want to swallow the small, but valuable competitor.

The wording alone shows that this attack causes the honorable Siemens gentlemen some mental problems indeed. Dr. Jochen Mackenrodt, managing director responsible for investments (previously investment management): "Don't talk about a hostile takeover, that sounds so military." The word "unfriendly" makes his stomach hurt considerably less.

Let's leave aside the semantic problems of the Siemens managers: A successful bid for Plessey in cooperation with GE would shake the European electrical/electronics industry in its foundations. In addition to Kaske and GEC chief Lord Arnold Weinstock, other competitors have formed powerful alliances as well. For instance, by taking over the European business of the American company ITT (including SEL) in 1986, French-owned Alcatel, a subsidiary of the government-owned Compagnie Generale d'Electricite (CGE) took the number one spot among European telecommunications companies away from Siemens. Even worse: internationally, the Alcatel-ITT team suddenly became number two next to the American telephone giant AT&T.

The Siemens counterattack, i.e. to acquire the French Compagnie General de Construction Telefonique (CGCT), was unsuccessful. The smaller Alcatel competitor was taken over by Ericsson, the Swedish telephone and computer company.

The Italian telecommunications company Italtel also did not want to face the future alone. After a long tug-of-war with Siemens, Italtel's owner, government-owned IRI, decided to go with AT&T.

Siemens-Telecom chief Dr. Hans Baur sees the worldwide merger mania as a logical consequence of rapidly increasing development costs for new communications systems. The Siemens manager predicts that "the next two years will show who the five or six survivors in the market will be. For the other manufacturers, it is only a question under whose roof they can take rescue."

The digital telephone communications system which Baur alluded to was developed by nine companies in Europe—each at a cost of approximately DM1 billion. In the U.S., a market comparable in size to Europe, only two manufacturers, AT&T and GE, were involved. Investment manager Mackenrodt: "Europe is wasting enormous sums."

Mackenrodt estimates that the following generation of communications systems—which will allow the transmission of TV-quality moving pictures via fiber glass—will cost at least twice as much with a useful life only one fourth that of current digital technology. After that period, this technology is expected to be replaced by another generation.

With these prospects in mind, Kaske is pushing his troups ahead. Siemens, he pronounced, must be among the "survivors", and at least not become a mere licensee in its traditional telephone and telecommunications area.

For these reasons alone, Kaske wants to succeed with his Plessey bid in England after the failures with CGCT (France) and Italtel (Italy). Siemens strategists agree that another failure would throw the company far back.

Kaske proceeded quite systematically. As early as August of last year, he met with Lord Weinstock at GEC headquarters in London in Stanhope Gate to discuss a possible cooperation. The Siemens boss had become interested in GEC because GEC and Plessey had combined their telecommunication activities in a joint subsidiary, GEC Plessey Telecommunications (GPT) in October 1987. Plessey which is strong in military technology and in the telephone area brought almost half of its sales of DM4.2 billion to the fifty-fifty joint venture, GEC (Sales of DM20 billion) only 15 percent.

From the very start, it was not a marriage made in heaven. The dispute over top management appointments alone delayed establishment of the joint venture until April 1988. Finally, the opponents agreed on GEC's Richard Reynolds as CEO of GPT and Plessey chairman John Clark as chairman of the board of directors.

The background for the dispute: The joint venture was formed primarily under pressure from the British government. Previously government-owned British Telcom, which commissioned and paid for the current digital communications technology "System X" developed by GEC and Plessey was returned to private ownership.

Kaske recognized instantly that GPT would no longer be the automatic supplier of the next system generation, but would have to compete with foreign suppliers—and in this field where billions are involved, GPT alone would not be able to succeed. Lord Arnold seemed to share his view. On November 16, Weinstock and his Siemens counterpart Kaske announced the hostile takeover of Plessey. The bitter defensive battle of the victim is dragging on, the outcome of the fight is uncertain.

However, one new development is bothering Kaske: To avoid becoming the victim of a hostile takeover himself, Lord Arnold agreed with the head of the American electrical giant General Electric (GE), John F. Welch, to cooperate in the fields of household products, medical technology, mass products and power plants.

This destroyed Kaske's plan to cooperate with GEC in the field of medical technology and to work together with GE on power plants. And the Siemens people could not understand at all that shortly before his GEC deal, Welch was in the same boat with Plessey chief Clark who wanted to pull through an unfriendly takeover of GEC together with other partners.

The cooperative agreement between GE (DM40 billion in sales) and GEC surprised even the experts of the City of London, in particular, because Welch transferred almost DM1 billion across the Atlantic to the British company.

The Siemens CEO fared better with his colleague John Akers, head of IBM, the world's largest computer company. Shortly before the end of the year, both signed a deal which is to bring Siemens additional sales of $1 billion in the U.S. in one go—in the important field of private telephone lines.

For the steep price of at least $800 million, Siemens will take over the two US-plants of Rolm, an IBM subsidiary. With help from IBM, a marketing network will be established for the sale of telecommunication products in the U.S., while the computer giant will also market the Siemens office communications system Hicom 300 under its own name.

IBM and Siemens - An Ideal Partnership

In the U.S., the Rolm deal has moved Kaske a big step forward, it jettisons Siemens to a number one position in the field of private branch exchanges practically overnight. In addition, both partners hope for considerable mutual benefits. Siemens, a traditional supplier of postal services with most of its know-how in central exchanges,

urgently needs new blood for the continued development of data technology. IBM, a classical data processor, knows too little about telephone technology. Both complement each other ideally.

However, Kaske does not yet know the exact purchase price for Rohm. If IBM will offset the Rolm losses—approximately $100 million per year—before the transfer, Siemens will have to pay $1.1 billion instead of 800 million.

Kaske also made a clever move by taking over more than 90 percent of the Bendix Electronics Group (sales of DM700 million) from Allied Signal Inc. at a price of DM300 million. Board member Hermann Franz in particular was the driving force behind the establishment of Siemens-Bendix Automotive Electronics with headquarters in Southfield/Michigan. Now, the Munich company which previously had been alone in the field of automotive electronics, has become a serious competitor for world market leader Bosch.

Almost no other market can expect a more rapid growth than automotive electronics. In 1985, the world market volume in this market amounted to approximately $5 billion, and it is expected that by 1995 more than $16 billion will be spent on fuel injection systems, engine controls and antilock braking systems.

Bendix can contribute know-how which was considered a Bosch exclusive for a long time: the production technology for the mass production of injection nozzles—a complicated, high-precision job. While the giants General Motors or Nippondenso are working with Bosch licenses, Siemens will be able to introduce for the first time a digital fuel injection completely independent of Bosch patents. The first test has already been scheduled: The new series 3 by BMW will be equipped with a Siemens injection starting in 1991.

Siemens To Make Strategic Acquisitions

Plessey, Rolm and Bendix—those three names represent a Siemens AG which has been reinvigorated by Kaske. In contrast to his attitude two, three years ago, Kaske acquires anything he can. "We have a lot of money," Dr. Horst Langer, head of Siemens U.S.A. since October, tells with a new touch of self-assurance. "And when it fits our strategic goals, we are willing to spend it."

To gain a stronger foothold in France, Siemens acquired the Paris computer firm IN2 (sales of DM300 million) in January 1989 and formed a consortium with the company group SAT, also located in Paris, to be able to compete in the field of digital mobile radio systems in France.

In Japan, Siemens formed a joint company together with Asahi Chemical, Siemens Asahi Medical Systems Ltd. (Siemens owns 66 percent) to produce and market nuclear magnetic resonance devices and other medical instruments—the basis for Kaske's goal to make Japan the second largest Siemens market for medical electronics after the U.S.

Japanese companies also helped Siemens enter the field of microelectronics. In 1985, Siemens purchased from Toshiba the technology for manufacturing one-megabit chips to make up for their belated start in microelectronics. The previous attempt at producing these minute chips on their own proved to be too time-consuming.

The result of the Toshiba connection is remarkable: In 1988, Siemens produced 3.5 million one-megabit chips; this year they plan to produce more than 20 million. At the same time, Siemens is trying to get production of the four-megabit chip in full swing in 1989—to the experts' surprise at about the same time as the Japanese. The basic structure of this chip was developed together with Philips. Losses of several hundred million DM in chip production last year are expected to be replaced by considerable profits in the early nineties.

One fact Kaske is particularly proud of: His progressive policy has made Europe again one of the major players in the international semiconductor industry. And that is not all: Recently, Siemens joined forces with Philips and Thompson in the Jessi project worth $4 billion to develop the 64-megabit chip.

By now, this innovation mania has been recognized in the U.S. as well leading to a large number of cooperative agreements with powerful high-technology firms: Cooperation with Advanced Micro Devices (AMD) in the field of integrated circuits for ISDN (June 1988); fifty-fifty joint venture with Intel (company name "BiiN") to produce and market computers for networked computer applications (June 1988); agreement with Westinghouse to sell stored-programm controls by Siemens under their own brand name (January 1989); long-term cooperation with Mips Computer Systems to supply Siemens with the 32-bit-risc processor family which is in great demand worldwide (February 1989).

All these agreements were made within the last year, when Kaske initiated his forward strategy. The sales of $3.1 billion in the U.S. in 1988 will probably double by 1990 due to the company's own growth and including acquisitions and joint ventures. That means he is halfway towards his goal of having the U.S. account for 25 percent of Siemens sales.

It is, however, unlikely that Kaske will manage to show a profit in the U.S. It will hardly be possible to reduce the loss of DM381 million in 1988 if only because of Rolm.

These will be the problems his colleague Horst Langer (53) is supposed to deal with. Kaske ordered Langer to the New York headquarters in October 1988. If he

manages to bring about a turn-around in the next five years and shows a profit for the U.S. company, his next career move will be almost assured: to succeed Kaske as CEO.

Interview with CEO Kaske

36980235 Munich INDUSTRIEMAGAZIN in German April89 pp 34-38

[Interview with Siemens CEO Dr. Karlheinz Kaske; place not specified: "We Are Taking Action"]

[Text] Siemens reacts to the merger efforts of its competition with a shopping spree. CEO Kaske explains his new offensive.

INDUSTRIEMAGAZIN: Dr. Kaske, Siemens AG is aquiring companies in the U.S., France and Great Britain more aggressively than ever before. Did the mergers and cooperative agreements of your competitors force you to follow suit?

Kaske: We are actually not doing anything new today. You will remember that we tried four years ago to buy the American firm Allen Bradley for approximately DM5 billion. However, this attempt failed. If we see a good opportunity to acquire another company which fits into our strategy we will act.

INDUSTRIEMAGAZIN: But the fact that you established a merger and acquisitions department shows that you are shopping more actively for other companies.

Kaske: We have always had this department, we just renamed it. After all, the world around us has also changed. When we bid for Allen Bradley, it was a sensational event. In the meantime, there have been mergers and aquisitions everywhere. Europe is getting ready for the time after 1992; new alliances are being formed. The world of electronics has begun to think more in global terms because technology has also become more global. In view of these developments, our actions are nothing unusual.

INDUSTRIEMAGAZIN: You haven't been infected by the merger mania virus?

Kaske: No. We never considered size a determining factor. If you look at our business activity, you will see that we are not very big in many areas. Siemens only has a broader product line than other companies.

INDUSTRIEMAGAZIN: That is exactly why it seems logical for Siemens to expand strategic areas to be able to compete on world markets? Take, for instance, the purchase of the automotive industry supplier Bendix, the pending takeover of Rolm from IBM or the takeover fight over the British competitor Plessey.

Kaske: True, we have been active in the field of automotive electronics for some years, because this is a market with a high growth rate. We have electronics know-how, Bendix is strong in automotive technology. This allowed a considerable expansion of our base.

INDUSTRIEMAGAZIN: Wasn't your start in the U.S. a rather late one? Your business activities there with sales of $3.1 billion are not very extensive compared to the size of your company.

Kaske: After all, we were able to increase sales by almost $3 billion over the past eight years.

INDUSTRIEMAGAZIN: Your goal to have the U.S. market account for 25 percent of Siemens sales is still far off.

Kaske: By now, we have approximately 27,000 employees in the U.S. and our added value is higher compared to other U.S. electrical/electronics companies. We also export a larger percentage from the U.S. than other U.S. electrical/electronics companies.

INDUSTRIEMAGAZIN: And when do you finally expect to start making money in North America?

Kaske: I cannot give a general answer to this question. We have profitable areas already now, others are still being built up. We are definitely making money in medical technology and in energy and automation technology.

INDUSTRIEMAGAZIN: Automotive electronics, i.e. Bendix, is still in the red?

Kaske: We generally see a very positive development here.

INDUSTRIEMAGAZIN: Telephone producer Rolm which you are taking over from IBM is supposed to become an important factor for your U.S. activities. When will the approval process be completed?

Kaske: That depends on the authorities. We hope to be able to sign the agreements in early summer.

INDUSTRIEMAGAZIN: Neighboring France and Great Britain where you have difficulties with acquisitions are other regional weak markets. Why is that?

Kaske: You have to look at history. There were times when Siemens was bigger in Great Britan than in Germany. That was at the end of the last century. In 1945, we were down to zero in many countries. This is undoubtedly one of the reasons why our presence in Great Britain and in France is relatively weak.

INDUSTRIEMAGAZIN: The takeover of Plessey together with General Electric Company would mean a big step forward in Great Britain. But what are you going to do if the unfriendly takeover will be rejected?

Kaske: If you look at the British market, you will find no alternative to Plessey in the field of telecommunications.

INDUSTRIEMAGAZIN: Failure of the Plessey takeover would be a set-back that could not be made up?

Kaske: No, it would only mean that present conditions would not change.

INDUSTRIEMAGAZIN: Did you expect such bitter opposition? You have to face a new battle formation almost daily...

Kaske: Twice a day.

INDUSTRIEMAGAZIN: Your opponents are experienced in takeover battles, while it is Siemens' first attempt. Are you a match for your opponents and partners?

Kaske: Well, you know, such takeovers are quite frequent in England and in America. We knew from the very outset that it would lead to public discussions. We have our attorneys, the others have their attorneys.

INDUSTRIEMAGAZIN: There is, however, the general impression that Siemens is not being met with open arms abroad. The Italian telephone company Italtel decided in favor of AT&T and against Siemens; in France, you made several unsuccessful attempts to acquire the telephone company CGCT.

Kaske: If you look at the structure of the French economy and then at the business activities of Siemens you will find that Siemens is represented well in the private sector. The difficulties are in government-owned markets. In Italy, our overall position is quite good.

INDUSTRIEMAGAZIN: Does the current reorganization of the company with the establishment of clearly defined and effective business units also aim at improving the ability of the individual divisions to cooperate?

Kaske: This is not the primary reason.

INDUSTRIEMAGAZIN: What is?

Kaske: When we established a structure for the Siemens AG in 1968, we had to find an organization which would be able to handle sales of DM20 billion in the future. By now, we have sales of DM60 billion. We need again structures which are flexible enough to handle the individual markets. We are forming business units for clearly defined tasks. These units must work as independently as possible based on market conditions and technology.

INDUSTRIEMAGAZIN: At least theoretically, this also gives you a chance to expand strategically important areas in a more purposeful manner and to withdraw more easily by selling off declining areas.

Kaske: That is speculation. Siemens has always had core areas such as energy generation, energy distribution, public and private communications technology or medical technology. We will continue to work in these areas. In the past decade, we added activities in office technology, factory automation and now automotive technologies. The semiconductor technology is the base for all these areas.

INDUSTRIEMAGAZIN: Siemens has invested a lot of money in semiconductor technology, not even considering government subsidies. Still, you are not able to show a profit. Will this investment ever pay off?

Kaske: If we were not convinced it will, we would not have committed ourselves so heavily. Still: We are not interested in becoming one of the largest memory chip producers. Rather, we need this technology in-house for the logic modules which will be built into the systems and isntruments. We cannot spend DM6 billion for research and development and come up with phantastic solutions and then take the drawings to somebody else and say: Now, make us the chips for this. As a systems house we must produce these key components ourselves. It is our basic philosophy to produce the system components at low enough costs so that they have no negative effect on the system. After all, we must be able to sell at competitive prices. Therefore, we also sell our chips to outside customers, because this is the only way of producing in large quantities and thus keeping costs reasonable.

INDUSTRIEMAGAZIN: Still, companies that only make chips would be even cheaper.

Kaske: This also means that the supply of standard memory chips would have to be unconditionally guaranteed. If we should one day need so many logic components that our plant could not handle it, I am quite willing to consider dropping memory chip production, provided that we can buy them on the world market. However, special components such as ISDN chips are not available on the free market. And we cannot give away our know-how. In addition, chip prices have increased drastically. Manufacturers that do not produce their own chips are becoming painfully aware of this.

INDUSTRIEMAGAZIN: And that is why you accept losses of hundreds of millions? At what volume will this area become profitable?

Kaske: That depends entirely on product prices. This year, we will produce a total of more than 50 million memory chips. Once you are a one-billion dollar company in the field of microelectronic chips you start to make headway.

INDUSTRIEMAGAZIN: How far are you away from this figure?

Kaske: We are moving towards it.

INDUSTRIEMAGAZIN: At what speed?

Kaske: I do not know what the price for the one-megabit memory chip will be at the end of this year. Currently, it is approximately DM30; it could be just as well be DM13.50. The Japanese make the prices. A few marks more or less per chip can soon add up to a few hundred million marks more or less.

INDUSTRIEMAGAZIN: How much of your chip production do you keep in-house?

Kaske: About a third. Two thirds are sold to the outside. It is our principle to sell to the outside to make sure that the products are right and our internal prices are not too high.

INDUSTRIEMAGAZIN: And how much do you buy from the outside?

Kaske: The various units buy between 50 and 70 percent of their requirements from the outside.

INDUSTRIEMAGAZIN: Why is it that Siemens must buy know-how from others again and again—be it production technology for the one-megabit memory chip from Toshiba or the license for the risc processors from Mips. Are the Siemens researchers too slow in their research?

Kaske: With the one-megabit chip we bought time; we will make the four megabit chip ourselves. And we can't produce everything ourselves. We all have our priorities. We are leading in bipolar technology, as an example. We make the fastest ECL gate. We make the best ISDN components and grant licenses for it. Overall, our licensing balance sheet is a positive one.

INDUSTRIEMAGAZIN: Dr. Kaske, if we assume that an international company such as Siemens has to be an active player in the three growth areas Europe, North America and the Pacific region, it seems that the current regional structure of Siemens is still quite uneven.

Kaske: We do business in 123 countries. Of those, a few experienced particularly strong growth in the past few years, also with regard to our activities. Take the People's Republic of China. Five, six years ago, our business was less than 100 million. Today, sales have increased tenfold. We are building our own training center in Peking, by now, we have a few hundred Chinese employees there. There is a lot going on in Japan as well. We joined forces with Asahi in the field of medical technology.

INDUSTRIEMAGAZIN: What are the key areas of your business with China?

Kaske: A country with such great infrastructure requirements needs many items we can offer—starting with energy generation, energy distribution to installations for steel plants or other industries. We are also active in telecommunications technology. For instance, we made an agreement for public telecommunications technology as well as private communications systems. Our business is growing in almost every area.

INDUSTRIEMAGAZIN: Still, the Federal Republic continues to account for 50 percent of your sales.

Kaske: You must not forget that we are a major supplier to German machinery plants and manufacturers of installations who again export a large number of their products. Overall, you can assume that approximately two thirds of our products are going abroad, either directly or indirectly. Europe accounts for about 70 percent of our direct sales, the rest of the world for about 30 percent. Of these 30 percent, the U.S. accounts for two thirds, and the remaining regions for one third.

INDUSTRIEMAGAZIN: But you can't possibly be satisfied with such a situation.

Kaske: We will certainly grow faster in the non-European markets than at home. There is a good reason why we commit ourselves so heavily in the U.S. and in other key markets.

SCIENCE & TECHNOLOGY POLICY

EC Commission Issues R&D 'Strategy Proposals'

AN890208 Brussels EC INFORMATION MEMO in English No P-20, 3 May 89 pp 1-4

[Article: "Research and Development in Europe and the Challenges and Changes in the 90's"]

[Text] On 6 June in Luxembourg, the 12 Member States will launch a crucial debate on the future of R&D in Europe. On the initiative of Vice President Pandolfi, the Commission has adopted a series of key policy considerations which will serve as a framework for the discussions.

Against a Background of Increasing Competition

The dimensions of Europe in 1992 should make it possible for European industry to substantially increase R&D investment. The European Community as it stands has several advantages to turn to account:

- It has 323 million inhabitants, or almost as many as the USA (244 million) and Japan (122 million) put together;
- Its economic wealth (1988 figures) is close to that of the USA (ECU 4,200 billion as against ECU 4,300

billion) and well above that of Japan (ECU 2,600 billion). The paradox is, however, that our main competitors—not only the United States and Japan, but also the fast-growing newly industrialized countries—are probably better prepared for the "shock" of 1992, in spite of the unfounded criticism directed at "fortress Europe." Unlike certain sectors of European industry, still hidebound by national perspectives, our competitors in non-member countries are ready to pounce on the opportunities afforded by a large market which has traditionally been open to the outside world. The 1990s will be crucial for the viability of European business. The information technology and telecommunications industries, in particular, should be able to benefit from the introduction of a range of new products and services, such as high-definition television, integrated broadband communications networks, etc., but competition from the USA and Japan will be fierce. According to a recent assessment by the Japanese Ministry of International Trade and Industry (MITI), some 21 percent of Japanese GDP in the year 2000 will be derived from goods, services and systems which make joint use of information and communications technologies. Japan already accounts for 60 percent of the world market for domestic electronics, a field in which the Community has a trade deficit of almost ECU 8 billion per annum. Meanwhile, the USA maintains its dominant position in data processing. The USA and Japan supply more than 80 percent of the world market for integrated circuits.

Japan and USA Make Greater Investments in R&D Than Europe

Yet another major disadvantage for Europe is the fact that both Japan and the USA each invest around 2.8 percent of GDP in R&D, as against 2 percent in the Community; and three Community countries alone account for 75 percent of the European R&D effort. By supporting long-term projects such as the Human Frontier Programme, Japan has set out to develop a wide-ranging mastery of the life sciences and basic research, enabling it to stay one step ahead of its competitors. In the USA, the Bush administration is making serious attemmpts to stop the gradual fall of industrial competitiveness in comparison with the Japanese. Consequently, federal funding of R&D should increase by 7 percent in 1990 and basic research commitments by 6 percent.

Changing Face of Science and Technology

In addition to increasing international competition, Europe also has to face up to new demands from the general public and a major change in the scientific environment. The quality of life has become a recurrent theme in European society, with demands for a cleaner and safer environment, more efficient and less costly health-care systems, medical advances in combating new diseases, education and training, safer transport and production systems, more wholesome food products, etc. In short, the whole acceptability of science is at stake. This new scientific environment is marked by the development of what experts call "pervasive technologies", i.e. technologies which have become the basic raw material of all advanced economies. Furthermore, such technologies are becoming increasingly short-lived, while the cost of their development is constantly increasing. For example, in the case of one of these modern-day raw materials, the microchip, the time scale between two generations of semiconductors (from 4 to 16 million items of information per chip) has fallen from 4 to less than 3 years, while the associated investment costs have doubled. Another profound change can be attributed not only to the breaking down of the artificial barriers between basic and applied research, but also to the emergence of multidisciplinary R&D activity. Lastly, the final change is that modern R&D requires increasing numbers of skilled personnel whose training needs to be constantly upgraded. In view of the total population figures, this challenge is of vital importance to the European Community. Europe is obviously at a disadvantage: Out of a population of more than 320 million, the Community has around 500,000 researchers and engineers, whereas there are 825,000 in the USA and over 400,000 in Japan, where the numbers are increasing rapidly.

Meeting Challenges

It is against this background of challenges, changes and the likelihood of fierce competition that the Commission is putting forward strategy proposals for action to the 12 Member States. These are in preparation for a thorough revision of the Community's R&D Framework Programme, on which the Twelve could reach a decision before the end of 1989.

R&D: Anticipating Competition and Standardization Stages

But Also More Aware of Market Requirements In general, the Commission is of the opinion that Community R&D as such must be limited essentially to the stages before competition and be built on a solid foundation in basic research. However, in specific cases involving emerging technologies, it should also be possible for Community assistance to be given to later stages of precompetition research projects (feasibility studies, pilot projects, etc.) which offer real potential for use in industry. In this case, the level of European and national financial support would be degressive, whereas investment by industrial partners would increase. In this context, the Commission is also of the opinion that there should be more regular interaction between Community R&D and EUREKA projects. The entry into force of the Single European Act in July 1987 gave the Community greater powers in the field of standardization. In particular, legitimate demands from the public concerning the quality of life (health, the environment, product safety, confidentiality of data processing systems, etc.) should

serve as the starting point for Community R&D leading to standardization, in conjunction with the industrial sectors involved. Such an initiative will make it possible to deal new challenges: cleaner cars, substitutes for CFCs, nuclear safety, genetic manipulation, etc. From this point of view the Joint Research Center is a special resource which the Commission may resort to directly.

European R&D: Concentration on Key Areas and Optimum Use of Human and Financial Resources

European research efforts must not be spread too thinly and rational R&D efforts must be coordinated to a greater extent at Community level. This is the substance of the Commission's message to the Twelve. The financial resources available for Community R&D are limited. It will be necessary, therefore, to be selective and concentrate on the key areas. "Pervasive" technologies must be given priority: Information processing, telecommunications, broadcasting, materials, and genetic and bio-engineering technologies. However, this selectivity must be accompanied by another priority objective, namely a simultaneous effort by the Twelve to coordinate national R&D efforts to a greater extent at European level. Finally, the Commission believes that more must be done to encourage greater mobility of European researchers, in particular by means of special financial arrangements. Over 60 percent of research workers have never studied or worked in another European country. Infrastructures and networks for training, exchanges of information and cooperation will therefore have to be improved. This would mean, for example, that young researchers could have easier access to scientific and technological installations and equipment in the various countries of the Community, which would be in the interests not only of mobility but also of economy.

EC Commission Describes 'Monitor' Program

AN890190 Luxembourg OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES in English No C144, 10 Jun 89 pp 5-6

[EC Commission document: "A Community Programme in the Field of Strategic Analysis, Forecasting and Evaluation in Matters of Research and Technology (Monitor) (1989 to 1992)"]

[Excerpts] The Commission of the European Communities has proposed a programme, "Monitor," which aims to identify new directions and priorities for Community research and technological development policy (RTD) and to help show more clearly the relationship between R&D and other common policies. The programme is thus mainly aiming at giving input to the Community RTD policy. The programme has a total budget of ECU 22 million. The Council of Ministers adopted on 14 March 1989 a Common Position on the programme, with a view to its final adoption. The programme includes three specific and complementary activities: SAST, FAST, and Spear:

1. SAST—Strategic Analysis

The function of SAST in the overall process of Community RTD priority-setting is to clarify and extend positions regarding the strategic orientations to be taken by the Community in the field of science and technology. The aim is to identify, for a given problem, the available options and give precise recommendations for action, account being taken of the S&T basis, the socio-economic context, the related Community policies, and the interests and opinions of the different parties concerned. For the purpose, research actions, of a duration ranging from a few months up to 12 to 18 months, will be launched that typically include:

a. The assessment of the European strengths and weaknesses of the European Community with respect to its R&D structures, a scientific field, a technology, a sector, the dissemination of research information, etc.;

b. The assessment of the state of development of a technology and its future evolution, the constraints to innovation, the areas of greatest socio-economic potential or intellectual promise when considering a particular field of action in S&T;

c. Determining the likely social, economic, and, where appropriate, environmental impact of a scientific discovery, a new technology, a new R&D initiative, etc.;

FAST—Forecasting

The FAST activity is a reoriented follow-up of previous FAST programmes. It will study the scientific and technological developments and the interactions with economic and social changes in the Community in the light of worldwide developments. The aim is to provide the Community with global long-term analyses in relation to the Community's major objectives in the 1990's, namely the creation of a single internal market and the strengthening of economic and social cohesion. The research actions will have a duration of up to one to two years and will include:

a. Forecasting reports on major topics or phenomena of a global character that may extend beyond the strictly European framework (e.g. S&T and social economic cohesion; the internationalization of technology and the economic, the long-term development of major world regions, the future of urban societies);

b. Applied assessment studies on the implications and consequences of selected scientific and technical developments that present important challenges for society in the future (e.g. the development of anthropocentric technologies and production systems, technologies related to health treatment);

c. Synthesis reports giving a critical analysis of the main forecasting studies published worldwide in specific fields (e.g. the biosphere, the future of public services, future scenarios).

Spear—Support Studies for the Evaluation of Community R&D

The aim of Spear is to provide the Commission with improved theoretical and methodological tools for the evaluation of the social and economic impact of its RTD programmes. The research actions include:

a. Horizontal evaluations, which will cover particular activities or mechanisms common to several RTD programmes (e.g. the effects of Community RTD programmes on social and economic cohesion, training);

b. Methodological studies to improve the methods used to conduct evaluations of Community RTD programmes, to measure the impacts of R&D programmes, to develop indicators and to draft guidelines for evaluations.

The Spear research actions concerned by this notice refer essentially to Point 3 (b) and will mainly take the form of an exchange of information and networks supported by a few contracts. SAST, FAST, and Spear will be undertaken through cross-national and multipartners projects, carried out by experts and organizations on contracts, or through scientific and professional networks. The projects will be executed in collaboration with, and supervised by, the Commission services. The Commission will pay up to 100 percent of the cost of research undertaken. [passage omitted] The first SAST, FAST and Spear research and network activities are expected to start by June/July 1989.

FRG: 1989 Max Planck Research Budget Approved

MI890234 Munich MPG SPIEGEL in German No 1, Mar 89 pp 23-24

[Article by Wieland Keinath: "1989 Budget: Go-Ahead for the Equipment Modernization Program"]

[Text] The Max Planck Society [MPG]'s board of directors adopted the organization's 1989 budget at its 10 November 1988 meeting. Budget expenditures amount to some DM1.238 billion. Total expenditures under the budget financed by the Federal Government and the Lands come to DM1.079 billion. Expenditures of DM159 million have been earmarked for the Max Planck Institute for Plasma Physics, which is supported by the Federal Government, the Land of Bavaria, and EURATOM.

In 1987 the heads of the Federal and Land Governments had decided to increase the joint subsidy to the MPG by 5 percent in the 1988 budget. For the first time in many years a real improvement in financial resources thus proved possible at the basic funding level. These extra resources will be used primarily to enable the society:

- to take up new research fields at existing MPG institutes, particularly by recruiting additional scientists, and
- to proceed further with the establishment of the Max Planck Institute for Polymer Research.

Last year, however, the society was unable to fund an equipment modernization program in the amount of DM60 million that was designed to reduce at least partially the equipment replacement backlog that has built up over the past few years. This involves not merely replacing equipment but procuring the latest generation of equipment which will enable the institutes to tackle new scientific problems more readily.

The MPG had termed the implementation of the equipment modernization program as another, necessary step toward financial consolidation. This is why it was the primary objective of the 1989 budget plan to include the equipment program in the jointly funded budget. The civil service pay settlement agreed in March 1988, which curbs increases in payroll expenditures at least up to 1990, made this goal easier to achieve. While the medium-term financial plan for the period from 1988 to 1992 that was adopted by the administrative council in early March 1988 showed an additional subsidy requirement of 4.8 percent for the 1989 budget year, the increase in the draft budget submitted to the Federal Government and the Lands in May 1988 amounted to only 3.9 percent or DM34 million, though the items to be covered remained the same. It was planned to increase the personnel roster by another 63 positions and to continue the special "young scientists" program (temporary program) by creating an additional 15 positions.

The draft budget also contained positions and funds for a Max Planck Institute for Computer Science and a cognitive anthropology project team. This expressed the MPG's eagerness to make its own financial contribution to the implementation of new projects out of the real increase in the financial base. It emerged during the negotiations with the pertinent bodies of the joint Federal and Land commission that each side was defending a different set of interests. While the MPG accorded top priority to the implementation of the equipment modernization program, the Lands, motivated by considerations of regional promotion policy, attached prime importance to their primary objective, the establishment of a Max Planck Institute for Computer Science in the Saarland, where there are no Max Planck Institutes to date.

1989 Budget of the Max Planck Society	Amount in DM Millions	Change Compared With 1988 (in %)
Payroll Expenditures	496.0	+1.3
Procurement Expenditures	248.6	+5.1
Current Subsidies	73.2	+2.5
Building Work	43.6	+3.8
Other Investments and Investment Funding	87.5	+13.4
Total Expenditures Jointly Financed by the Federal Government and the Lands	948.8	+3.5
Revenues	34.1	+10.2
Subsidy Requirement	914.7	+3.3
Special Funding	27.6	—
Project Funding	102.7	+2.9

The Federal and Land Governments rejected the idea of making the establishment of the institute dependent on a special financial contribution from the Land in which it is located, because this would contradict the principle of the framework agreement on joint research funding.

The draft budget with its 3.3 percent or DM29 million increase, as approved by the heads of the Land Governments, makes allowances for both positions. The budget provision of DM10 million advocated by the MPG for the equipment modernization program is under consideration, and provision has been made for a DM2.7 million joint subsidy to the Max Planck Institute for Computer Science in 1989. It is important for the establishment of the Max Planck Institute for Computer Science that the Federal and Land Governments have stated that they will also endeavor to make the necessary budget funds available in the coming years, within the framework of their basic funding program. The Federal and Land governments have also approved another 15 temporary positions. So far under this program, a total of 50 temporary posts for scientists have been made available. Of the 63 new permanent posts requested, however, only 11 were approved, specifically for the Max Planck Institute for Polymer Research. In this context it is necessary to bear in mind that the federal minister of research and technology can approve new positions only if an identical number of positions are established at other research institutes subsidized by the Federal Government.

Attention is drawn to some other important projects and programs:

- The budget contains the funds required to continue seting up the Max Planck Institute for Polymer Research.
- It was possible to include in the budget provisions the current expenditures and investment in equipment involved in making seven appointments already decided or planned.
- It was possible to raise the number of subsidized places for doctoral candidates from 650 to 680 and the number of grants for non-graduate scientific assistants from 175 to 200. Fostering the careers of young scientists thus remains a key aspect of the MPG's funding policy.

When adopting the Federal Government's 1989 budget, as it did the previous year, the Bundestag again excluded 3 percent of jointly financed research institutes' procurement budgets from coverage by grants. While it was possible in 1988 to reduce this position to 1.5 percent of procurement expenditures, roughly DM3.7 million—though only after long drawn-out negotiations with the Federal and Land Governments—a settlement satisfactory to the MPG may be anticipated for 1989. In response to a request from the heads of the Land Governments, and in view of the federal research minister's willingness to make this cut elsewhere in the budget, the federal finance minister has since agreed to essentially exempt the MPG from the freeze in 1989. The freeze does remain in force, however, for the procurement expenditures of the general administration.

COMPUTERS

GDR: P8000 Compact Programming, Development System Examined

23020074p East Berlin MIKROPROZESSORTECHNIK in GermanNo 5 1989 p 160

[Text]General

This system was first exhibited at the 1989 Leipzig Spring Fair. It was developed by the Elektro-Apparate-Werke Combine, Berlin-Treptow and is the first East German system to incorporate the U80600 microprocessor system built by the Microelectronics Combine in Erfurt. By incorporating a Winchester disk drive in the basic system configuration, the system's volume was reduced by 50

. The P8000 compact is equipped with two hard disk drives which can be managed using either the WEGA or WDOS operating systems. Two floppy disks serve as a mass storage device when using the UDOS or OS/M operating systems. In this latter case, two additional external floppy disks are also available. For the WEGA or WDOS operating systems, the floppy disks are used only for backup storage.

The U8001 CPU circuit board has five available module slots. One of them is taken up by a battery-backed system clock. The remaining four module slots can accommodate up to four 1 Mbyte RAM circuit boards (comprised of 256 Kbit chips) for the U8001 [processor] (8 Mbytes are addressable). Thus, when the WEGA operating system is used, it has an available RAM capacity of 4 Mbytes. Using the WDOS operating system requires two module slots—one for the U80601 CPU circuit board and one for the 1 Mbyte dual port RAM circuit board. The WEGA main memory is responsible for insuring that the WEGA operating system can still manage 2 Mbytes of RAM capacity and that 1 Mbyte of RAM capacity is managed by the WDOS and WEGA operating systems functioning in parallel.

The P8000 compact is equipped with eight V.24/IFSS [not further expanded in text] channels. Either P8000 terminals, printers, emulators or remote computers can be connected to these channels. The "remote computers" are PCs operating as terminals in multiuser mode under the WEGA operating system.

The system's erasable programmable read only memory (EPROM) programmer is connected via a parallel 8-bit interface and is suitable for programming EPROMS of the following types: 2716, 2732, 2732A, 2764, 2764A, 27128, 27128A, 27256, 27256A and 27512.

Operating Systems

The P8000 compact offers the user four possible operating systems. The UNIX-compatible (UNIX version 7 or UNIX System III) WEGA operating system is designed for multiuser and multitasking operation. It runs on the U8001 processor and contains a hierarchical file management system, has an I/O rerouting capability and can handle pipeline and filter processing as well as accommodate a shell command interpreter. The system language is C. The WEGA operating system includes around 2000 service programs, making up the UNIX tool inventory, an assembler and a C-compiler. When using the U8000 processor, WEGA has programs for text processing (nroff, troff) and computer interconnection (uucp, remote) as well as a system for managing user source programs (source code control system).

The second 16-bit operating system, WDOS, is partially compatible with MS-DOS. It runs on the U80601 processor and can be used in single user operation on one of a maximum of eight terminals under the control of the WEGA operating system. The user has available 640 Kbytes of RAM capacity. System and user programs from MS-DOS-compatible computers can be executed, provided that they operate line-by-line. The WDOS operating system can function in parallel with the WEGA operating system since it runs on another processor.

The two 8-bit operating systems are the RIO-compatible UDOS and the CP/M-compatible OS/M (version 2.2) which are run on the U880 processor. While UDOS contains software systems for the development of user software for the U880, U881...886 and U8000 processors, with the OS/M operating system, the effectiveness of auxiliary and related processes, specifically text processing (WS-compatible) and database work (dBase II-compatible), can be increased.

The P8000 compact provides hardware and software developers with a system enabling program development and testing for all types of processors available in the GDR (U880...886, K 1810WM86/88, U80600). Thus, work can be done in multiuser operation.

Technical Parameters

Dimensions of the basic device (h x w x d)	420 x 260 x 395 cubic mm
(Serial) interface	V.24 (maximum 10 m) IFSS (maximum 500 m)
Floppy disks	2 x 5.25" disks, each with a maximum capacity of 1.6 Mbytes;optional 2 x 5.25" external units
Hard disks	One or two 5.25" disks, each with a capacity of 43 Mbytes

Module slots	5
Main memory	a maximum of 4 Mbytes of RAM capacity on four circuit boards, each having a 1 Mbyte capacity
U8001 CPU circuit boards	4 serial interfaces
U880 CPU circuit boards	DRAM with a 64 Kbyte capacity; the use of two external floppy disks is possible
U80601 CPU circuit board with a 1Mbyte dual-portRAM circuit board	on two module slots (thus making available a maximum of 2 Mbytes of RAM capacity for the U8001 CPU circuit board)
Clock	battery-backed (takes up one module slot)
Terminal	VT100-compatible with a K7229 monitor (monochromatic, alphanumeric)
EPROM programmer	for 2716 up to 27512 EPROMS
Single chip computer-emulator	for EMR [expansion not given] of the U881 series
Operating systems	UDOS (RIO-compatible) OS/M (CP/M-compatible) WEGA (UNIX-compatible) WDOS (partially compatible with MS-DOS)
Expansion software	WEGA-CROSS (assembler and compiler for U880, U881 and K 1810WM86) WEGA-WORD (text processing) WEGA-CALC (tabular calculation) WEGA-DATA (database system) WEGA-REMOTE (for star-shaped computer network configuration with PCs) IRTS-8000 (for real-time applications)
Programming languages	WEGA-BASIC WEGA-PASCAL WEGA-FORTRAN 77
Power supply	220 V plus or minus 10-15%; 50 Hz; 150 VA

FACTORY AUTOMATION, ROBOTICS

Flexible Automation Advances on Display at Leipzig Fair

23020050 East Berlin FERTIGUNGSTECHNIK UND BETRIEB in German No 3, 1989, pp 137,140, 146

[Article by G. Kranert]

Introduction

In accord with the slogan of the Spring Fair in Leipzig for 1989, "Flexible Automation", the major emphasis of the Heckert exhibit planned has been further automation of the manufacturing processes. From the production program of numerically controlled individual machines, work centers, production cells and flexible manufacturing systems, representative exhibits were selected which characterize the breadth and versatility of the product assortment and the efficiency of the combine. Determining factors in the strategy of developing the product structure are market requirements, taking international trends into account. The new and continuing developments in the highly productive manufacturing facilities for processing partial prismatic assortments are designed to adhere to the technological requirements of the users, largely conforming and conceptually geared to increasing technological requirements for the future.

They permit modular construction of the work stations in conjunction with varying peripheral construction groups. Representation of the following examples of some exhibits will clarify this further.

1. Flexible Production System FMSP 630/2

By supplementing the flexible manufacturing systems developed during the last few years and used in various sectors of the metalworking industry, the parent company completes the construction series with the FMSP 630/2 and thus closes the requirement gap. This is the most automated product within the 630 series. By integration of peripheral processes into the work sequence in the complex manufacture of automated parts, flexible production systems represent a new generation in manufacturing facilities.

The Flexible Manufacturing System FMSP 630/2 consists of linearly combinable system modules which can be varied as a function of the technological task at hand and client requirements with respect to their numbers. The Fair exhibit represents a partial section (Figure l) of the system.

Major components of the complete manufacturing system are: Work center CW 630/2)S in system execution with microprocessor control CNC 700. (Figure 2—FMS module Horizontal Work Center CW 630. [not reproduced]) Wet tension removing station ESTN 630 with storage)programmable control SPS 7000 Rail)guided transport roboter with lifting device STR-H (control CNC 7000) including rail facility and shelf device Stretching area Readying station for workpiece loading and unloading process Manufacture and facility control Main operating position.

All controls are products of the VED Numerik "Karl Marx". The automatic interaction of the system modules mentioned through CNC and SPS in conjunction with

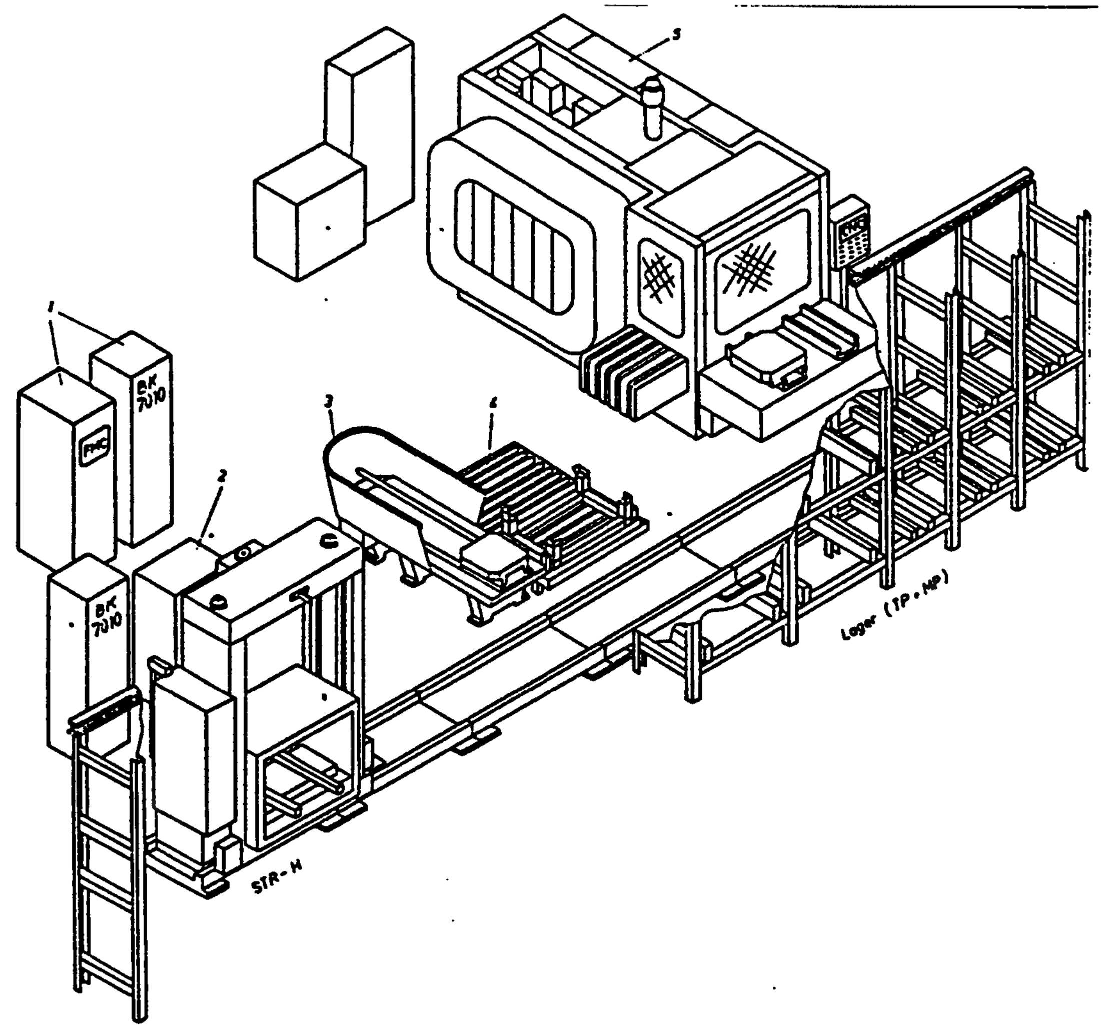


Figure 1. Flexible manufacturing system FMSP 630/2*1 with STR-H; STR-H rail transport roboter; TP + MP transport) and maschine pallets 1 Production control; 2 facility control; 3 Stretching area; 4 Readying area; 5 Processing system.

facilities for process monitoring form the basis for low-attendance manufacture with the required work accuracy. The system can work in different types of operation, up to computerized system operation in its ultimate capacity. The varying degree of automation corresponds to the requirements of different client demands.

The processing module CW 630/2 achieves the largely complete milling and drilling treatment of shaped workpieces with a maximum edge length of 630 mm on four sides in a mandrel.

It underwent substantial further development in some essential technical parameters. Such serviceability improvements are, for example, new workpiece stores with larger storage capacity and reduced space requirements. The possibility of arranging double workpiece stores permits storage of up to 160 workpieces per work station. This allows manufacture of a wide assortment with multiple shape elements without requiring feed for the stores.

Simultaneous with the workpiece store, a new workpiece exchange device iss used, which reduces by means of the shorter span times (10 s) the auxiliary time component and thus leads to an increase in productivity. In order to be able to utilize highly effective workpieces with progressive cutting values, the speed range of the work screw was increased and now amounts to 20 to 5,000 rpm. Introduction of the process lubricant can proceed optionally through the screw center or over nozzles at the screw head, and there is a spray lubrication device for threading. The work space of the operating stations is completely screened off to protect the environment. Changed drives in the spacing shafts (WSM 3 from VEB

NILES Stellantriebe Dresden) and the micro processor control CNC 700 are additional details with respect to innovations. The rail-controlled transport roboter has a lifting device and manipulates both machine and transport pallets in the system. The entire workpiece flow from storage of the blanks in the shelf store to delivery of the perfectly assembled finished products is organized via the system control. In the highest stage, a manufacturing control computer (FMC) assumes in addition to the workpiece flow other functions of the system module of the FMS.

2. Processing Centers and Manufacturing Cells

The following are exhibited as newly and further developed processing centers and manufacturing cells: the manufacturing cell FCBFK 130/2 for working on large components up to a maximum of 6,000 kg workpiece mass, fitted with a system*compatible workpiece pallet exchange acting in X direction (VEB Werkzeugmaschinenfabrik UNION Gera) the manufacturing cell FC 400 K/3.2 for working boxshaped workpieces of up to 400 mm edge length, provided with a pallet exchange system for workpiece feed, including eight store areas (VEB Werkzeugmaschinenfabrik Auerbach) the vertical processing center CS 500 which, due to its modular construction, allows variable adaptation to the technological task (VEB Werkzeugmaschinenfabrik Saalfeld).

These exhibits are type representatives of the product assortments in each case and are fitted with CNC 700 controls. Compared to the CNC 600, this provides benefits such as: Increase in the number of controllable axles (max. 8), Generatable path resolution per axle (0.1 [m]to 100 [m)] Greater store volume (40 K in integrated PC and approximately 100 K NC program store), Control guidance in clear text, tool exchange routine for 240 tools among others increases function content.

In accordance with the requirements of automated production, the VEB Mikromat Dresden has continued development of the product series two-stand coordinate drilling machines BKoZ 1400. The Hochgenauigkeits-Bearbeitungszentrum CBKoZ (Fig. 3) is type representative of a variation series finding its most sophisticated version in the FMS module. Special accuracy- and productivity-determining major construction groups were improved in both their technical parameters and reliability. For example, the main drive was developed further decisively in its performance (from 13.2 kW to a maximum of 22 kW, torque increase from 800 to 1,000 N . m), and machine accuracy in the axles was increased among other things by improved function structuring, use of new measuring systems etc. (position uncertainty 8 position scatter 5 [m)]. With constructive reworking of all axle drives with respect to the use of WSM 3 engines, the feeding power of the cutter bar could be increased to full power for drilling. Serially, the control generation CNC 700 is used for the entire construction series.

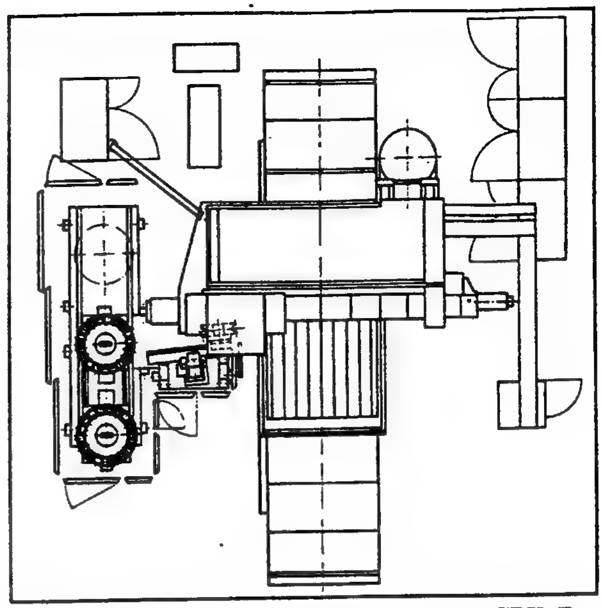


Figure 3. High accuracy processing center CBKoZ 1400/2

The processing center is fitted with a completely new concept of an automatic, modularly structured tool exchange in different stages. The tool storage tower constructed in several horizontal planes can accommodate in tandem design up to a maximum of 144 tools. For broader technological requirements, the tool capacity can be expanded by tool store exchange (Fig. 4). In another version of the exhibit, the possibility of linkage between identical machines or with other products, provides integration into flexible production systems.

Use of the high-accuracy processing center CBKoZ 1400 x 2240/2 is conceived for sectors in which, in addition to accuracy requirements with a high automation degree

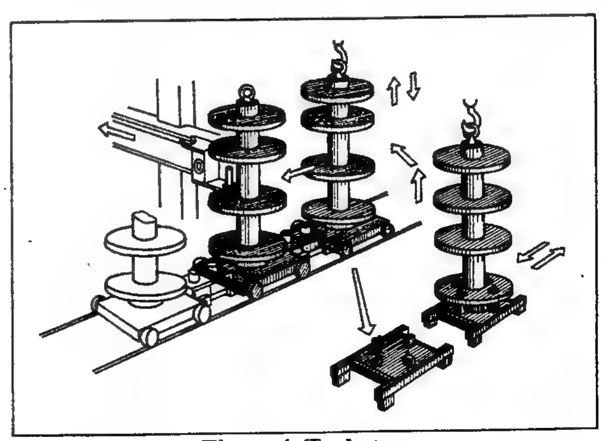


Figure 4. Tool store

and high repetition accuracy, machining performances are also high. For example, when milling C45 steel with a 160 mm diameter cutter head, a cutting volume of 360

cm ^{3}/min was reached. To process drilling, a caliber accuracy of less than 10 [m]is guaranteed.

3. Processing Centers and Large-Component Processing

The Werkzeugmaschinenfabrik Aschersleben is the manufacturer of tool machines for processing large components. Limited exhibit areas, on the one hand, and large area requirements for these machines, on the other hand, have led to a situation where for quite some time only model information was given at fairs about continued developments in this product group.

Develoment of a new construction series of large-component processing centers had already begun several years ago with construction size 4. Meanwhile, this construction series was completed upward by Size 45 and downward by Size 3. This makes highly automated large-component processing machines available in portal construction for processing widths of up to 3,200 mm and for maximum workpiece heights of up to 3,000 mm. Graduated, variable table lengths of up to maximal 12,200 mm mounting length and table loads of up to 16 t/m allow adaptation to the actually existing part assortments in each case.

Different automation devices and automation construction groups allow in conjunction with the CNC control continuous and effective processing in the milling, drilling, drilling out, circular milling, hollowing and grinding processes, as well as in threading. For these, milling supports with spindle powers of up to 45 kW are available, depending on construction size. Via a tool exchange, tools with a maximum of 315 mm diameter, 500 mm length and 50 kg mass can be exchanged automatically from a basic tool store with a capacity of 96 storage places. Additional devices, such as angle cutters [Figure 5 not reproduced] , precision cutting facilities, universal angle cutting devices with spindle drive powers between 4 and 35 kW, as well as planer allow for complete technical processing of five workpiece sides with high productivity in one setting. Special client needs and new processing tasks are taken into account in the constant continuing development of accessories and complementation of the assortment.

Figure 5 Angle cutting device Accessory exchange was automated, reducing both the time for the exchange and the load on servicing. The processing centers are made complete with efficient chip removal and coolant facilities. The construction series of the large-component processing centers CFZ takes the place of the large-component processing machines produced to date in house. 4. Store-Programmable Control SPS 7000

The automation degree of machine construction is determined to a large extent by efficient, safe function control techniques. During the last few years, the combine has taken steps to develop and introduce new control technique generations. This concerns the broad application of the CNC 700 developed in the control of processing centers and manufacturing cells of up to eight axles, the development of the modular control system 7000 on the basis of a 16-bit technology, of which the SPS 7000 is used as the first component in controlling highly automated conventional machines.

With the SPS 7000, the VEB NUMERIK Karl Marx-Stadt has created a modular, store-programmable control system which, with expanded function properties and improved utilization properties, succeeds conventional control devices and broadens the usage range of this control category. It can be used in many branches of the industry and is employed mainly in the area of processing and work machine building for automation. This new generation is put to use, for example, in the periphery of the FMSP 630/2. Control is conceived for the average to high performance sector (maximum of 2,048 digital entries/exits). Outside of construction groups for the detection and output of digital signals, there are groups for the input of analog quantities and the disposition of analog values. At the same time, the processing speed was improved considerably (1 microsecond/variable). In addition to bit processing, control has a multitude of algorithms for byte or word processing and, in conjunction with special construction groups, communication possibilities.

For communication, connection of terminals for process observation and process servicing is possible; a printer can be connected for recording. Several SPS 7000 can be coupled to a compound control system.

Considerable software is available for programming and start of operation, guaranteeing rational utilization of the SPS 7000. There is a multitude of function building blocks for complex control functions, so as to simplify programming and structure it in an easily understandable manner.

MICROELECTRONICS

Bulgarian Controller for Real-time Image Processing Described

22020010 Sofia ELEKTROPROMISHLENOST I PROBOROSTROENE in Bulgarian No 4, 1989pp 11-14

[Article by Atanas P. Totev and Doyno I. Petkov: "Controller for Device Determination of some Discrete Random Image Characteristics in Real-time"]

[Text] Modern television measuring systems usually have automatic measuring track control subsystems such as: exposure time, amplification coefficient, and others. The purpose of these subsystems is to ensure reception of measurements optimized according to one or several criteria depending on the subject specialization of the specific measuring system, for example: according to maximum signal/noise ratio. During the designing of

subsystems with similar function specifications, a problem with the existing elements has emerged. It is relatively difficult to achieve the necessary stability of control parameters in a wide temperature and dynamic ranges using analog integrated circuits (5) because parameter requirements for power packs are higher and analog-to-digital conversion is relatively complicated to accomplish. The use of specialized processors for image processing (1) is not very effective because there are no devices within their structure to identify frequently used statistical characteristics of the processed images and additional IS [Integrated Circuits] are necessary.

It is possible to solve this problem by using the controller which has been developed. The structure and functions of the developed controller were demonstrated by the design, and its effectiveness was validated by testing the automatic control system of the optoelectronic matrix transducers of elements with load leads as part of the Video Spectrometric Complex 6 of the international project for exploration of the planet Mars and its satellite, Phobos.

The controller is designed to be produced in two technological versions: the first one is a module circuit board which is a model to test the concept and prepare for the second version: a specialized integrated circuit of the CMOS [Complementary Metal Oxide Semiconductor] base matrix crystal (BMK) type. Some specific BMK circuit engineering requirements were noted during the design of the first version, related for example, to input and output buffers. Universal logic function CMOS circuits identical or similar to the program packet for BMK design already present in the library were used.

The controller uses standard interface subset of the CM [Computer] 600 family of microprocessor circuits (2); a 4-bit address, 8-bit data pathway, the signals "select controller," "read/write," and "data pathway accessible." This makes it directly applicable to microprocessor systems with this type of interface. The controller's processing blocks (and correspondingly the "input data" pathway) are of the 8-bit type, enabling it to process multiples of 8-bit data paths by connecting additional controllers in parallel. Input data is entered into the controller together with a cycle time signal which also serves to synchronize the function of cycle logic elements. For convenience, during formatted data processing supplemented with usable or other information, two signals have been programmed: one to block the controller's operation temporarily while saving the current result values, and the other to zero all internal registers with results. Control registers, output data registers, and the status register are positioned in the very same address space to minimize the address space occupied by the controller. The control registers are activated only in the "write" position, while all others are activated only in the "read" position of the microprocessor bus. During the design of algorithms for work in synchrony with incoming input data it is necessary to synchronize the input data, the input data strobe signal, and the "data pathway accessible" signal of the microprocessor bus in order to avoid errors.

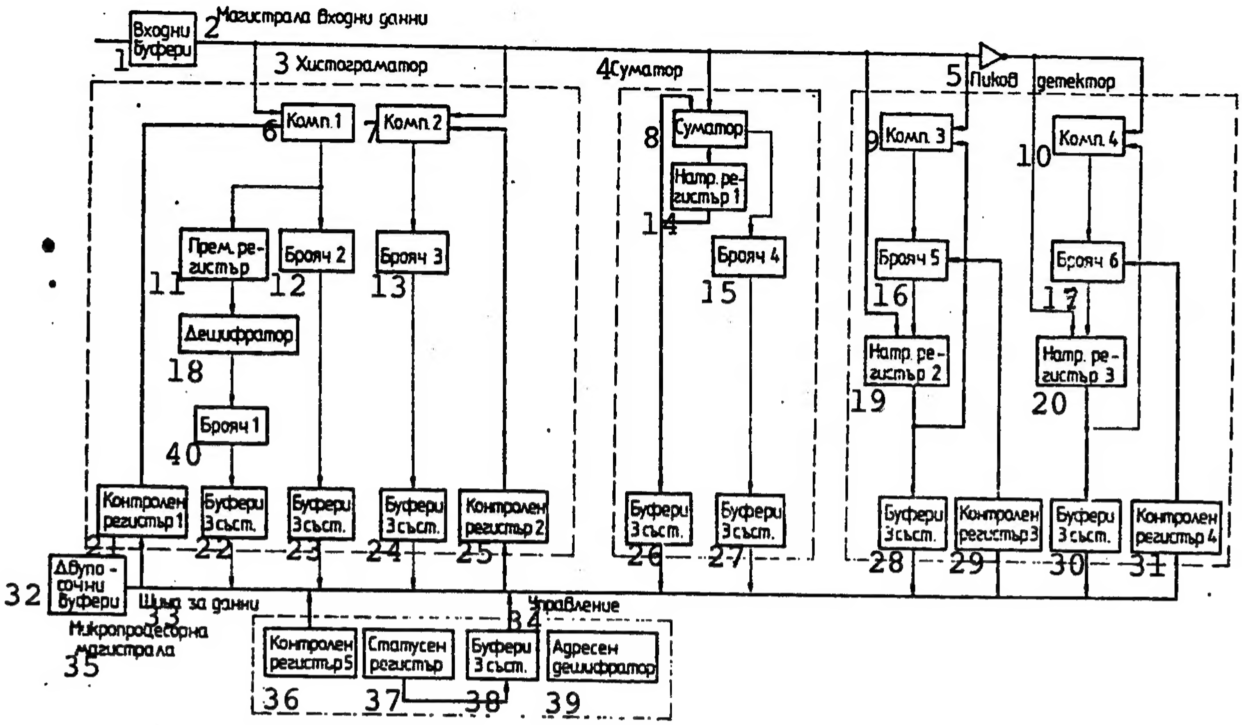
Description of the Controller's Functions and Structure

The block diagram of the controller is shown in Figure 1. It is composed of four functional blocks:

Histogram Generator. Two quantities from the discrete quantity signal range (from 0 to 255) are entered in control registers 1 and 2. The approximate values of the distribution density probability of the processed discrete random images in intervals equal to one discrete increment are determined in the block by forming a histogram (3). In many cases, it is possible to identify the observed image or the observed measuring track data transmitter by using two characteristic points of the distribution density function (4). More density function points can be obtained during stationary processes by designing a synchronous algorithm and program changes in the quantities entered into control registers 1 and 2 at definite time intervals. Eight bit comparators and 16-bit counters are used in the block. A 1-bit digital high frequency filter is included in the third channel of the histogram generator by using an 8-bit displacement register and decoder. Signals with repeat period equal to 1, 2, 3, or 4 discrete increments in the time field are separated through the filter. The effect of "high frequency noise" can be evaluated and the relationship between the contribution of "noise-like" and "large-scale" entities in the evaluation of density distribution can be determined with the help of this channel. Saturation signals for counters 1, 2, and 3, go to the controller's status register.

Summing Amplifier. The approximate value of the first row moment, or the "statistical mean value" in non-standardized form is determined in the block (3). During the organization of a synchronous algorithm it is possible to also calculate a "creeping mean" by noting the value of the current sum during definite time intervals. No measures to take into account the influence of noise have been taken in this block because the most commonly encountered noise in technological systems is of the non-correlated type and it is known that its influence decreases with integration, while the influence of correlated noise can be evaluated in advance. The block is constructed to include an 8-bit full summing amplifier whose overflow signal is transferred to a 16-bit counter. The input and output signals of the summing amplifier are transferred so that they can be used for parallel work with additional controllers.

Peak Detector. The block consists of two identical parts: the first one is used in determining the signal's maximum value, and the second (after sending an inverted input signal to it) is used in determining the approximate minimum value. The block's structure includes 8-bit comparators, 8-bit programmable counters, and makes a



1 - Input Buffers
2 - Input Data Bus
3 - Histogram Generator
4 - Summing Amplifier
5 - Peak Detector
6 - Comparator 1
7 - Comparator 2
8 - Summing Amplifier
9 - Comparator 3
10- Comparator 4
11- Displacement Register
12- Counter 2
13- Counter 3
14- Accumulator Register
15- Counter 4
16- Counter 5
17- Counter 6
18- Decoder
19- Accumulator Register 2
20- Accumulator Register 3
21- Control Register 1
22- Buffers, 3 components
23- Buffers, 3 components
24- Buffers, 3 components
25- Control Register 2
26- Buffers, 3 components
27- Buffers, 3 components
28- Buffers, 3 components
29- Control Register 3
30- Buffers, 3 components
31- Control Register 4
32- Two-way Buffers
33- Data Path
34- Control
35- Microprocessor Bus
36- Control Register 5
37- Status Register
38- Buffers, 3 components
39- Address Decoder
40- Counter 1

Figure 1.

simple but effective algorithm for suppressing high frequency noise interference during polling: "a new quantity is recorded in register 2 only if the value of the input signal has been consecutively *K* times greater than the current value found in the register." The value of *K* is determined by control register 3.

Control. The block contains an address decoder, microprocessor bus control logic, control and status registers. The signal levels which zero the data registers and the counters, and the signal level to suspend temporarily the controller's operation are assigned by control register 5. In addition to overflow signals for the histogram generator counters and the summing amplifier, there are some signals going to the status register to indicate the working order of the controller.

The final form of the controller's circuit engineering on the basis of BMK is expanded by introducing additional logic blocks and leads which improve diagnosis conditions and facilitate circuit testing.

Conclusion

The design's basic advantages are:

simple and effective implementation, fulfilling the requirements for work in real-time; having almost the same performance, the controller constructed on the basis of BMK surpasses controllers with similar functions carried out with analog integrated circuits and with specialized digital processors for image processing when compared according to amounts of space occupied and energy consumed;

optimum selection of adequately informative characteristics of discrete random images permitting to solve a variety of problems related to measuring track parameter control;

the specialized device is implemented as a microprocessing controller using one of the most widely available types of buses, facilitating the design of a variety of algorithms for data processing and control of information and measuring processes.

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GDR: New Technique for Manufacture of High-purity Metal Targets

23020075p East Berlin NEUES DEUTSCHLAND in German24-25 Jun 89 p 12

[Text] Last May at the Mansfeld Combine in Niederroeblingen, a trial run of a new field of production for the manufacture of metallic targets for microelectronics was begun. In the manufacture of microelectronic components, targets ("target disks") are those materials from which, by using noble gas ion [bombardment] in a vacuum, atoms are broken loose and precipitated as a thin metallic layer upon silicon chips.

Scientists at the Freiberg Combine-Research Institute for Nonferrous Metals have managed to register an advance in the field of aluminum targets since their patented vacuum refining technique for the production of high-purity aluminum is more lucrative and more cost-effective than the internationally recognized conventional technique.

Describing the new process, Dr. Manfred Raschke, one of the innovators, stated that, under prescribed conditions, indigenous high-purity raw material is smelted in a high vacuum, thus vaporizing the sodium in it which would otherwise destroy the semiconductor properties of the silicon [being sputtered]. He went on to say that targets manufactured using the new process contain a sodium atom for every ten million aluminum atoms, thus fully meeting the purity requirements of the microelectronics industry.

Furthermore, if aluminum is used on a chip, as a conductor, chromium alloy targets are used as resistances in the electronic components. Based upon results achieved by the Academy-Central Institute for Solid State Physics and Materials Research in Dresden, the Research Institute for Nonferrous Metals in Freiberg has also developed a new technique for producing these alloy targets.

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